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THE CHANGE OF GOVERNMENT.

To no section, perhaps, of the English community outside the purely political is the recent change in the *personnel* of the Administration of the British realm fraught with more interest and importance than to the rapidly-extending electrical world. There is so much just at this moment engaging the attention of electricians, electrical engineers, and financiers interested in electrical enterprises that affords an opportunity for the application of abstract political principles and the exercise of considerations of general policy, that any fundamental change in the constitution of the authority having the power to carry out this application and this exercise must necessarily affect the interests involved and those interested, very considerably. The Ministry which has just retired has so utterly failed to advance, where it has professedly sought to do so, the interests of the various branches of electrical industry which it has legislated for or taken under consideration, that we are almost bound to think that the change cannot be otherwise than for the better. The most ardent partisans of Liberalism—or Radicalism, for that has been the dominant power in the late Ministry—can scarcely have the audacity to claim that Mr. Chamberlain's Electric Lighting Act of 1882 has done aught to promote the welfare of the electric lighting industry; whilst those Liberals who are electricians will readily confess that, at the very least, a grave mistake has been made.

Unfortunately it is not certain that the altered condition of things in Parliament is such as to permit of any positive reversal of previous plans. The Conservative Government will have quite enough to do to attempt to settle the unsatisfactory state of affairs domestic and foreign which they have inherited, to transact the necessary official business, and to prepare for the impending political campaign; and to expect it during the few short months at its command to introduce anything in the shape of initiatory or remedial legislation upon such comparatively unimportant matters as electric lighting or overhead telephone and telegraph wires is somewhat unreasonable. To look beyond the present year of grace and predict what will be the relative power of parties in the future, or even what parties will exist, requires more prophetic vision than ours: we can only hope for the best.

We are not without hope, however, that some amelioration of the difficulties which electric light providers in particular have to contend with will be effected by the aid of the new President of the Board of Trade, His Grace the Duke of Richmond. The cry of injustice has been so persistent, and the effect is so strongly in evidence, that the new Minister can scarcely neglect the opportunity to perform one gracious act and one for which he will be borne in grateful remembrance long after the Salisbury Administration has become a thing of the past. What makes the hope stronger is that it is now generally known that the views of Mr. Chamberlain himself had undergone a slight modification, and that he was latterly not unwilling, had the opportunity occurred, to concede something to his influential memorialists. With this knowledge to go upon, the new President will probably have all the less reluctance in endeavouring to bring about a relaxation of the restrictions now imposed by the Electric Lighting Act.

In the matter of overhead wires, the very strong and well-reasoned recommendations of the Select Committee of the House of Commons must commend themselves to the incoming Government, which may be trusted to take a more common sense view with regard to private rights and the practicability of those recommendations. We (wise after the event!) think we trace the motive which dictated that announcement of the late Government, that it did not intend to follow up the report of the Special Committee by any legislation, considering the recommendations impracticable, and, if carried out, too great an invasion of private rights: even then, the scrupulously sensitive Ministry was looking forward to the coming struggle and saw an excellent opportunity of demonstrating how, even in apparently small things, it was closely regardful of what may be termed the private rights of the general public individualised, when these were sought to be invaded by unscrupulous and monopoly-representing corporations. The conciliation of the professional or the "fad-ish" agitator was more to be desired than the actual benefit of the public, which is much too apt to believe what is told it by anyone with a plausible story. When it is seen, however, that with further powers conferred upon it an invention of great utility, which has, from various causes, been kept unwarrantably in check in this country, will be placed more extensively in the hands of the public, that public may be depended upon to condone any seeming interference to a trivial extent with the rights of the individual. We learnt from Mr. Brand last week that the United Telephone Company, which, just at present, is perhaps most interested in the matter, is fairly confident that the recommendations of the Select Committee will become law; and if the Conservative Government is responsible for effecting this, we venture to think the fact will never be remembered against it.

Upon another matter we are less hopeful. The appointment of Lord John Manners to the office of Postmaster-General has probably given rise to extravagant hopes that very shortly a sixpenny telegram, with free addresses, will be offered to a grateful and long-expectant nation. The fact that the new Postmaster-General, when in Opposition, stood valiantly up for free addresses, does not necessarily imply that he will, in office, feel himself committed to the introduction of a measure upon that basis. Indeed, we venture to think he will not attempt to do anything at all in the

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matter. We are not inspired, however, and should he do so, would commend to his careful attention the scheme propounded by Dr. Cameron, and detailed in the REVIEW for June 6th, wherein he will find much more promising material than will be afforded by any attempted reconstruction of Mr. Shaw-Lefevre's plans upon the basis of entirely free addresses. We have before expressed our general approval of Mr. Shaw-Lefevre's proposals, accepting his statement that they were the utmost the Department could do without incurring a loss in working—and this statement, so far as our knowledge extends, has not been controverted. We see no reason why Dr. Cameron's ingenious suggestions should not be adopted in conjunction with a similar scheme, and a sixpenny telegram of moderate dimensions be thus rendered possible.

Whether any or all of these subjects will receive the attention of the incoming Ministry, and whether they will legislate upon them or not, it is impossible to say; but, at any rate, we are convinced that if nothing is done it will be solely in consequence of the exigencies of the exceptionally difficult situation in which the Government finds itself.

ON ELECTRIC TRAMCARS.*

By A. RECKENZAUN.

IT may be premature to read a paper on the subject of electric tramcars, considering that at this moment there is only one such car in existence, in this country, as far as the author is aware; this solitary example, moreover, has only been in operation, experimentally, since October last, therefore the invitation of the council of this institute was accepted with a considerable amount of hesitation.

The Inventors' Institute has a privilege before other societies in this respect, that it will judge of the merits of an invention as an invention, apart from the commercial aspect of the problem. Utility, however, is the first desideratum in an invention, and the author now submits to this institute the bare question of utility.

Before going into the details of our subject, it may be interesting to dwell for a moment upon the figures given in this table, which was prepared in order to show what power a pair of horses are capable of exerting.

TABLE.

Power exerted by two horses in pulling a car with passengers, weighing 4½ tons. Tractive force 30 lbs. per ton.

At 7 miles per hour on level road				...	2·52 H.P.
„ 6 „	„	„	„	...	2·16 „
„ 6 „	„	gradient	1 in 75	...	4·32 „
„ 5 „	„	„	1 in 37	...	5·4 „
„ 4 „	„	„	1 in 37	...	4·32 „
„ 3 „	„	„	1 in 25	...	4·32 „
„ 4 „	„	„	1 in 25	...	5·76 „
„ 5 „	„	„	1 in 25	...	7·2 „
„ 3 „	„	„	1 in 18	...	5·4 „

The additional power necessary to pull a car round curves cannot be ascertained with the same accuracy; it depends upon the radius of the curve, the amount of play in the axle boxes, and the size of the wheel flanges. A flexible wheel base will considerably facilitate the movement on curved roads, and wet rails offer less resistance than dry ones.

The force required to start a car and to get up speed is necessarily greater than the force required to maintain the speed uniformly. It is a variable quantity, says Mr. D. K. Clark in his admirable book on Tramways, for it may be anything that horses choose to exert.

But it has been found by experiment that the momentary starting force is about four times the tractive force when once in motion; thus we may form a rough idea as to the exertion of a horse in starting a car on the level or on an incline.

Horses cannot tell us of their sufferings; we know merely that their life in tramway service is short, although they do not work longer than three to four hours a day. It seems barbarous to use horses as these figures show, still there has been no economical substitute until recently, and it is only within the last few years that mechanical traction has made any headway. That mechanical power will supersede animal power, and that at no distant date, is admitted on all hands, and the question of the kind of mechanical power to be employed is still an open one. It is often asked why so much mechanical power is required for the propulsion of tramcars, and why it is necessary that a tramway locomotive should be made to give as much as 40 indicated horse-power, whilst two horses seem to do the same amount of work.

The above table shows what mechanical work is actually being done. James Watt ascertained experimentally that a strong dray horse was capable of producing a continuous effect of 33,000 foot pounds per minute, but we see that one tram horse does the work of three dray horses very frequently. When we now consider that a tramway steam locomotive weighs from 8 to 10 tons without the car and passengers, it becomes evident that the indicated H.P. just given is no extravagant measure. Take a locomotive engine, car and passengers, weighing together 14 tons; in order to move that load on a level road with 30 lbs. tractive force per ton, and at a speed of seven miles an hour, we require between 7 and 8 actual H.P., which is equivalent, after allowing for engine friction, to about 11 I.H.P., and in travelling up an incline of 1 in 37 this power will amount to something like 34 I.H.P.

Reducing our figures to a co-efficient, and maintaining that the tractive force is 30 lbs. per ton on a level but dirty road, we come to the conclusion that when moving at the rate of seven miles per hour on a straight line we consume in round numbers 8 foot pounds of work per minute for every pound weight on the rails; on an incline of 1 in 75 we consume 16 foot pounds; and on an incline of 1 in 37, 24 foot pounds for every pound weight carried at the same speed. Therefore it is of the utmost importance to reduce the dead weight to be propelled to a minimum. When a locomotive engine has to drag the car behind it, it becomes necessary to provide weight in order to obtain good adhesion on the rails, and the best plan no doubt would be to utilise the weight of the car and passengers to furnish the requisite adhesion.

The number of steam locomotives employed on tramways is daily increasing, and steam traction is gaining in public favour. It is not within the range of this paper to examine into the advantages or disadvantages of steam traction, but merely to show whether electric cars have any chance of success from a utilitarian point of view.

We distinguish between the terms electric car and electric tramway or railway; the electric car carries its energy within and it is quite independent of external influences, whereas with electric tramways the energy—electricity—is conveyed from the generating station to the rails or other conductors communicating with the motor which turns the car wheels.

Separate conductors are used by Messrs. Siemens and Traill at Giant's Causeway and elsewhere. Mr. Magnus Volk, at Brighton, conveys the current through the rails; the nature of the ground on the Brighton beach does not allow of any accumulation of wet and dirt; the rails are above the level and there is no traffic across the line. An electric tramway is now being constructed at Blackpool, where the current of electricity is to be conveyed through conductors in a pipe laid underground; this pipe has a slot throughout the whole length to permit of the connection between the car motor and the conductor beneath the surface of the road.

Our electric tramcar requires no conducting medium; it does not interfere with the rails or roadway, nor with other traffic, can be readily shifted from one line to another of the same gauge, and it can be run in conjuction with the horse cars.

THE BATTERY.

The first requisite for an electric car is a battery which can be stowed away within the car. Such battery has to be of small weight; it must be reliable, supply any quantity of current, according to the requirements of the road, and it must be cheaper to maintain than horseflesh, and emit no smell. Primary batteries were out of the question; the cost of zinc and acids consumed in them would be much greater than the cost of animal power, independent of the difficulties attending the process of refilling such batteries when exhausted.

The invention of the secondary or storage battery put the question entirely in a new light. Certain successful laboratory experiments at once suggested the adaptability of this invention to the propulsion of vehicles. Four years have elapsed since the introduction of the Faure accumulator into this country; it caused quite a sensation at that time, and money could be found in abundance for the exploitation of anything that bore an electrical name. Things have changed entirely since then. The original Faure battery has never been of any practical service, and very substantial improvements had to be made, at enormous costs, to bring the secondary battery to a commercial value. The Electrical Power Storage Company have acquired the patent rights of M. Faure, in addition to those of Messrs. Sellon, Swan and Volckmar, and they have, step by step, improved the mechanical details of these secondary batteries till they arrived, after fearful labours and expenses at what may be termed a thoroughly practical article. But the prejudices created in the public mind by early failures have not quite worn off yet, and it will require something wonderful and startling to convince the public that the work of the last four years has produced remarkable improvements. None but those who have been intimately connected with the manufacture of storage batteries can form an idea as to the numerous difficulties which had to be surmounted before a permanent success was obtained. The battery was long ago perfect from a theoretical point of view, but it could not stand the test of time. Time was

* Read before the Inventors' Institute, May, 1885. Mr. C. E. Spagnoletti, President of the Society of Telegraph Engineers and Electricians, in the Chair.

an essential factor; it took many months to test the durability of a set of cells, and it was only by close observation and careful remedying of defects one by one as they appeared that the storage battery assumed its present form—simple as it may appear to the uninitiated.

The cell before you is one of a set of the type specially designed for tramcar work. In a lead-lined strong teak box are placed 21 lead plates weighing together 26 lbs., inclusive of connecting strips and terminals: 10 of these are called positive and 11 negative. Each plate is formed of a lead grid, the perforations of which are filled with a paste of lead oxide; the positive plates contain red lead which, in charging, is converted into peroxide, and the negative grids are filled with a paste of litharge which, in charging, is reduced to spongy lead capable of absorbing hydrogen. We store, therefore, not electricity, but oxygen and hydrogen, which gases, by discharging the battery, manifest themselves externally in the form of electrical energy.

This box is filled with sulphuric acid and water at a specific gravity of about 1,150°; then a lid is put on sealed all round the edges to prevent any spilling of acid. This acid is never removed so long as the battery lasts. There is no reduction of lead or any material going on within the cell, and the battery would last for ever, but for the fact that the lead grid of the positive plates becomes so brittle with oxidation that it crumbles to pieces in the course of time, then these positive plates have to be replaced periodically by new ones, but the old lead is valuable. The life of a positive plate depends entirely upon the amount of work it has done. The plates in the box before you have been at work since September last year and they are still in excellent condition—we should say they are still as good as new; they have frequently been discharged at the rate of 100 ampères, whilst the average working current is 46 ampères; these cells are always being charged at the rate of 32 ampères, and the storage capacity of a cell is 150 ampère hours. Sixty such cells will weigh 1¼ tons and propel a car with 46 passengers for about two hours over a road with ordinary inclines, curves, and 60 stoppages per hour. The diagram represents a car which has been running at Millwall and at Battersea. The accumulators are placed on trays under the seats, out of sight. These trays can be drawn out through doors at one end of the car and replaced speedily. A trolly containing a fresh set on trays and rollers is drawn up to the end of the car; the discharged cells are pulled out altogether by means of a small winch, and the newly charged ones pushed in, when the car is ready to proceed on its journey.

There are three sets of accumulators to each car, two sets charging whilst one set propels the vehicle, thereby time is saved and waiting prevented.

The Electro-Motor.

This machine has to convert the electric current into mechanical power. For tramcar propulsion it is absolutely necessary that the motor should have a high efficiency and at the same time be of small dimensions and little weight. To combine these requirements has been the aim of the author, and he has at length produced a machine, shown on the diagram, which has had some rough tests in actual service under the most trying circumstances and conditions.

There are two motors driving the car each capable of working up to nearly 9 horse-power, and weighing 420 lbs. Each motor is supported independently upon a small bogie; the whole mechanism is self contained, and each separate bogie forms a small locomotive engine upon which the car rests. One axle of each bogie is a driving axle, thus we obtain four small driving wheels which give the requisite grip upon the rails. Either bogie can be detached from the car in less than one hour, so that in case of repairs and inspection the motor can be taken out and replaced without letting the whole car stand idle for any length of time.

The Gearing.

The speed of the motors is necessarily high, about 1,000 revolutions when the car runs at seven miles per hour, thus it is necessary to introduce some mechanical reducing gear between the motor shaft and the driving axle. The gearing employed consists of a worm on each motor shaft and worm wheels on the driving axles giving a ratio of about 1 to 12. The worm gearing is boxed in, likewise the motor, and the wheels run in oil; dirt is thereby excluded and the lubrication is perfect. Easy access is obtained to the motors and lubricators through doors in the floor of the car.

Variation of Speed and Power.

This is obtained by means of a compound switch which arranges the motor circuits so that the machines shall work in series, in parallel or singly, thus the resistance of the circuit being varied, the power and the speed varies accordingly. When a greater range of speed is desirable, the motor circuits are still further divided by arranging the field-magnet wires apart from the armatures. This obviates cumbersome gearing which would add to the weight and expense, increase first cost as well as maintenance.

The driver has full command over the motive power; one handle suffices for all the operations of starting, stopping and varying the speed or power. There is no useless electrical resistance and therefore no waste of energy whatever speed the car may be travelling at. The car is provided with these details at both ends, so that the driver has merely to remove the handles at the end of a journey and two connections, and then proceed. It would be an easy matter to vary the speed by decreasing or increasing the number of cells and thereby vary the electromotive force. This method, however, is injurious to the accumulators, because some of the cells would be discharged sooner than the others, and when they are all re-charged in series, some would have to be very much overcharged before the rest could receive their share. There would not only be a waste of power occasioned by the evolution of gases for no purpose, but the life of the cells and their efficiency is reduced by this irregular treatment.

Brake Power.

At each platform there is the usual vertical shaft and brake handle. A chain is wound upon this shaft, when the handle is turned, and eight brake blocks are simultaneously pressed against the corresponding number of wheels. The car can be stopped almost instantaneously. Besides this there is an electrical brake, so that the motors act as dynamos driven by the momentum of the car, or by the car running down an incline; the whole of the power stored up in the momentum of the car is converted into electricity, and the current generated is utilised in magnetising the brake blocks, thereby increasing their grip upon the wheel tyres. Arrangements are being made to render this electric brake automatic, so that the main circuit will be broken and the brake circuit with the motors closed automatically when the speed of the car reaches a certain maximum.

Cost of Motive Power.

It has been mentioned that the capacity of the tramcar cells is 150 ampère hours; we do not exhaust them entirely, but leave a margin of at least 20 per cent. in the cells; 120 ampère hours' charge is sufficient to propel the car full of passengers for two hours, or about twelve miles, over an average road with frequent stoppages. When charging 60 cells at the rate of 32 ampères for four hours, and replacing the accumulators in the car every two hours, we require steam power to the amount of about 15 indicated horse-power per car. Assuming that the car has to run 72 miles in a day, and that we are supplying several cars at the same time from one engine, the fuel consumed need not exceed 4 lbs. per I.H.P. per hour. The charging takes place during 12 hours of the day only, thus 7 cwt. of coal per car per day will give a consumption of about 10 lbs. of coal per mile. Reckoning the price of coal at 18s. per ton, the fuel per car mile would cost less than one penny. By working longer hours we could do with smaller engines, but of course with the same consumption of coal per car mile. The most economical steam tramway locomotives burn from 9 lbs. to 12 lbs. of coal per mile, or about the same as quoted for the electric car. There are two reasons for this high consumption—firstly, the steam locomotive weighs four times as much as the accumulators and electric motor driving gear, therefore it requires greater power for its own propulsion; and, secondly, a tramway locomotive boiler and engine cannot be expected to compete with a large stationary engine and boiler as regards economy. Thus the loss arising from the conversion of steam power into electricity, and the reconversion of electricity into mechanical power, is more than compensated by corresponding advantages. There are instances where water power is available within a reasonable distance from the tramway depôt, and in such instances the additional economy will be apparent.

Prime Cost, Maintenance and Depreciation.

The steam engines, boilers, dynamos and shafting, and all necessary apparatus for a charging station to supply a dozen electric cars, including spare power, will cost £4,000; and the complete equipment of 12 two-horse cars, inclusive of ample spare gear, may be estimated at £6,000. The superintendence of machinery at the charging station will cost £1,100 per annum; fuel at 18s. the ton, water, oil and waste, £1,400; 10 per cent. depreciation on engines, boilers and dynamos, £400; and with an estimated depreciation of 35 per cent. on the whole propelling apparatus, we get a total expenditure of £5,000 per annum, which is equivalent to 3·5 pence per car mile run. You will observe that these figures are thoroughly reasonable, and allow of a good margin. We should have to almost annihilate the whole concern at the end of a year in order to bring the working costs to an amount allowed by some tramway companies for horsing.

The following is a summary of the principal points in favour of this system:—

1. Economy in running cost.
2. The electric car has the same appearance as those in general use, and any ordinary car can be readily converted.
3. The wearing parts of the mechanism driving the wheels are few in number and easily replaced.
4. The weight of the motive power is less than 2 tons, distributed over two small bogies.
5. The propelling apparatus is invisible to the passengers, practically noiseless, clean and free of danger.
6. One man (not necessarily skilled) can drive the car.
7. The car may be illuminated at night by the electric current sufficiently to enable the passengers to read comfortably. The power required to maintain the electric light is so small that the cost may be neglected from the estimates, for the lamps (giving together 40 candle-power) consume only 3 ampère hours out of 150 given by the cells.
8. The maintenance of the permanent way (paving) must be less than in the case of tramways where horses are used, the hoofs of which follow always in the same tracks.
9. The space required for a charging station for the secondary batteries is much less than that necessary for stables for horses to do the same work.

10. The same plant which charges the storage batteries may be utilised for lighting the depôt and even buildings in the neighbourhood.

DISCUSSION.

Prof. GEORGE FORBES, F.R.S.E., gave a short and concise account of the electric railways laid down in various parts of the world within the last few years, and he considered the methods of conveying the electricity through rails or other conductors clumsy and unsatisfactory. In Mr. Reckenzaun's tramcars they had no stationary engine connected with it by a conductor, and this, he considered, other things being equal, a very great advantage. After the experiments made by M. Philippart with tramcars propelled by a Faure battery he was glad to hear Mr. Reckenzaun say that storage batteries had at last been made commercially useful and practical. He now believed the difficulties which had encountered secondary battery makers in the past had been surmounted, and that the method of constructing them had been so enormously improved that those who used them were now masters of the situation instead of *vice versâ*. Pointing to the battery exhibited on the table, the speaker said everyone was struck with its light weight, which was brought about by its being made of thin plates, thus giving a large surface and a greater current than had ever been found before in a secondary battery. This he considered one of the chief things they had to be thankful for, because this bringing within a small compass sufficient power to last for a few hours had been their stumbling block in the past. He had been informed that it was impossible to overcharge these batteries, and that this could be done for months and months, but it is mentioned in this paper that this overcharging is detrimental to their working. The method of varying the speed and power devised by Mr. Reckenzaun is extremely ingenious and simple, avoiding the disadvantages of mechanical arrangements which would necessarily arise with numerous wheels, chains, or the like. As to the efficiency of electrically propelled cars as compared with other means of locomotion, he thought that although steam had made great progress of late years in the propulsion of tramcars it still had very serious drawbacks, among which were that a small portable locomotive was far less economical than a stationary engine, especially as for the former they had to use a superior quality of fuel. Comparing the Scott-Moncrieff compressed air car with the one then under discussion Prof. Forbes remarked that it seemed to him that the arguments which applied to one applied to the other, and also pointed out that in Mr. Reckenzaun's car they saw for the first time the application of a worm wheel to reduce the speed of the motor. In conclusion he said it was satisfactory to hear that Mr. Reckenzaun was using electricity itself as a brake upon his car, because he thought that where electricity was applied as a motive power it ought also to be used as a brake power. (Hear, hear.)

Mr. TRAILL (Giant's Causeway Electric Tramway) said that electric tramway engineers had a great battle to fight. They did not want to replace steam but to aid railways, and at the same time the outside public. He thought that through electricity underground railways would become things of the past. There was also the system of overhead tramways such as was used in America, and which the electric motive power was essentially fitted for as it did away with the noise and dirt. There were four systems of utilising the electric energy, and there was no doubt that the system of carrying its own motive power, self-contained in its own car, had very great advantages indeed over any other system. The different systems were those which had overhead conductors, those which had side conductors, those which had underground conductors, and the system of accumulators. The overhead conductor was suited to very few places; then there was the side conductor which they had adopted on the Giant's Causeway tramways. This system was very economical and had many advantages, but after all was only applicable in very few places. Then there was the underground conductor could be adapted to street tramways. The fourth system, viz., that of accumulators, had many advantages; indeed, it could be used on any line now worked by horses or steam. After repeated failures at the Giant's Causeway they had at last hit upon a thoroughly reliable plan for getting the electricity from the conductor. This was by means of a steel spring in the form of a carriage spring; two concave steel springs fastened at the top and rubbing along the bottom.

Prof. FORBES: How long do they last?

Mr. TRAILL replied that they had some running for nearly a year, and when new they only cost 5s. 6d. He was very much pleased with the system of Mr. Reckenzaun, and having no doubt that it would come into very large use, he wished it every success. (Hear, hear.)

Mr. BERNARD DRAKE was of opinion that electric cars would have to be made smaller than those which had up to now been constructed in accordance with Mr. Reckenzaun's designs. He pointed out that not only would the smaller cars be more tractable in case of accident, but also that the question of stopping the car would not be so serious, as it stood to reason that if there were 46 passengers in a car instead of 23, the driver would be required to stop double the number of times in a given distance, and that the question of starting such a big car as now used was a severe strain. He considered that the arrangement adopted by Mr. Reckenzaun of coupling the motors in series or parallel, or running a single motor, was both ingenious and practical; but as regards the overcharging of the extra cells, he thought that the question was more one of carrying the dead weights of these extra cells, which Mr. Reckenzaun had so ably explained was of the greatest importance in ascending gradients, than the mere destruction of the cells themselves. It was, of course, wasteful to expend your power in the evolution of gas after the cells were full, and would tend somewhat to soften the peroxide, which might therefore be more liable to drop out when jolted by the car; he maintained, however, that the overcharging was not nearly as detrimental as was generally supposed. Mr. Drake drew attention to the large output per pound of lead obtained from the tramcar pattern of cell, and the general practical nature of the supporting of the plates and connections, and stated that as managing engineer of the Storage Company he felt certain that the company was greatly indebted to Mr. Reckenzaun for the development of the cells in connection with this class of work, inasmuch as numerous questions of detail had been found out by him, and that by these experiments a most valuable advance had been made in this class of accumulator. Referring to air cars, he thought there were very decided advantages in favour of the electric car, not only in weight, but also from the fact that the pressure of air began to fall from the moment the car came into use, for which mechanical arrangements had to be provided, and also the freezing caused by the expansion of air had to be faced; whereas in the electric car the E.M.F. is practically constant throughout the run, also the electric car would hold its charge for weeks together, whereas the air car charge would entirely leak away in a night.

Mr. TRAILL rose again, and stated that his cars in Ireland have successfully travelled over 30,000 miles with 100,000 passengers, and that the electricity generated by water-power a mile distant costs one-quarter of steam used on the same tramway. The commutator of the dynamo made 22 millions of revolutions before it required repairing.

Mr. SHOOLBRED, M.I.C.E., said that he had seen Mr. Reckenzaun's car running on a difficult piece of line at Battersea, and he was struck with the simplicity of the system, and the completeness of design in every detail. He thought that Mr. Reckenzaun's plan of varying the power and speed was just as applicable to a tramway having the current supplied through conductors as it is with accumulators.

Admiral SELWYN, in the course of some general remarks, said he hoped the Inventions Exhibition would help the inventor to take his proper place in the country, instead of being absorbed by the manufacturers, which was after all only one result of a defective patent law.

Mr. WAUGH having spoken in encouraging terms of the prospects of electrical engineering, the CHAIRMAN called upon Mr. Reckenzaun to reply.

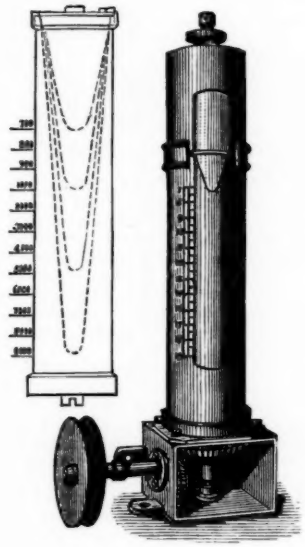
Mr. RECKENZAUN, in reply, testified to the great pleasure and instruction he had derived from the observations of Prof. Forbes, Mr. Traill and the other speakers, and that he felt highly encouraged by the remarks of such authorities. He pointed out that the comparisons made by Prof. Forbes between compressed air cars and electric cars do not hold good in all points, although there is a great similarity in principle. Compressed air cars are much heavier; the weight of the air reservoirs under the car and its engine cannot be less than four or five tons if made to run eight or nine miles with a pressure of 500 lbs. to the square inch; the accumulators, motors and gearing in the electric car weigh under two tons in order to propel the vehicle with 46 passengers over a distance of 12 to 14 miles, and the time occupied in changing the cells at the end of the journey need not occupy more than three minutes. The moving parts in the mechanism of the air car, like those of the steam car, are at least five times in number as compared with the parts on the electric car, and this must be taken as a very great advantage. Moreover, the efficiency of the compressed air engine is lower than that of the accumulator and electric motor. Mr. Drake has very justly said that whilst the pressure in the air car is gradually falling, the current of the electric battery is constant throughout; but as regards Mr. Drake's opinion that small cars may be more efficient than large ones, Mr. Reckenzaun remarked that a car capable of carrying only 23 passengers will weigh much more than one-half the weight of a 46 passenger car, and that if the traffic is sufficiently large the bigger cars may be more economical. As regards the overcharging of the batteries, if some cells were used more than others of the same series, which would occur were the speed and power regulated by the number of cells, more stress should have been put in the text of the paper upon the fact that the energy wasted is more serious than the fact of sooner oxidising the lead plates. Still, the object of the present system of regulation removes both these drawbacks.

The CHAIRMAN then moved a vote of thanks to Mr. Reckenzaun which was seconded by Admiral SELWYN and carried unanimously.

Telegraph Revenue.—The telegraph service produced the following in the quarters named:—Quarter ending September 30th, 1884, £485,000; December 31st, 1884, £430,000; March 31st, 1885, £405,000; June 30th, 1885, £445,000. The revenue in the corresponding quarters of the previous year was:—Quarter ending September 30th, 1883, £485,000; December 31st, 1883, £435,000; March 31st, 1884, £390,000; June 30th, 1884, £440,000. There is thus an increase in the last quarter as compared with the corresponding quarter of £5,000, and an increase for the whole year of £15,000.

HEDGES'S SPEED GAUGE.

THE accompanying engraving, which we reproduce from *The Engineer*, illustrates a novelty in the way of speed indicators, which has been introduced by Mr. Killingworth Hedges as a simple and cheap instrument for reading the speed of dynamos or other quick running machinery. The instrument, termed the Vortex Indicator, is simply a removable glass tube, which is revolved in a metallic case furnished on its outside with a sliding ring, the tube being partly filled with water. When revolved the water has a tendency to creep up the side of the glass and imprison the air therein contained, carrying it down in a parabolic form, which is elongated as the speed increases. The bottom of the bubble gives the speed, which is easily ascertained by getting the two fine wires of the sliding ring in line, the revolutions being marked on the case. Mr. Thomas Blakesley, M.A., has investigated this instrument mathematically, and has devised



a formula by which the angular velocity of the water which causes the depression for any given speed can be ascertained without experiment. The depression is always proportioned to the speed, so that the calibration of the instrument is far simpler than those other forms of speed indicators in which the ordinates vary with the increase of speed. As far as we are aware, Mr. Hedges' instrument, although not new in principle, is unlike all others in having the divisions at equal distances, and should prove of great utility for registering the speed of locomotives, and perhaps may be adapted for ship work. Several of these indicators are at work in the electric light shed of the Inventions Exhibition.

SECONDARY BATTERIES.

IT seems that the time has now arrived for electricians to gain a thorough insight into the mysteries of secondary battery working, and to decide amongst themselves, with a considerable degree of certainty, as to the future of these apparatus.

The literature on this subject is, compared with that available on nearly all other matters appertaining to electric lighting, very meagre, therefore it is well to put on record in a technical journal anything bearing upon such an important factor in the progress of electrical science.

In the *Times* of January 20th, 1883, the following letter appeared from the pen of Mr. J. S. Sellon, and as the remarks contained therein are equally of value now as then, we herewith reproduce that communication in full. We may add that Mr. Coope's installation was referred to at the time in our columns; the query of "Enquirer" was in effect asking Mr. Coope whether he could, as in the case of gas, make use of his light during any part of the day or night:—

Sir,—The admirably descriptive letter of Mr. Coope's electric light installation at Berechurch Hall, which appeared in the *Times* of the 16th, will have given to the thousands of readers who, I venture to believe, are interested in the progress of electric lighting, the practical information of which they were so much in need. The definite figures and calculations will serve as a guide to many who may have been imbued with the erroneous belief that domestic electric lighting was far more costly than is the case. Now that the real facts are made plain a great impetus will be without doubt given to private electric lighting, and electric lighting generally.

The point raised by "Enquirer" in the *Times* of yesterday is, however, calculated to cause much discouragement, could it not be satisfactorily disposed of, for naturally one of the first essentials for any system of lighting for permanent adoption must be that the light shall be available at any and every moment it may be needed, and it would be hopeless to expect any favourable competition with gas illumination if this requirement cannot be fulfilled.

The drawback indicated by "Enquirer" is, therefore, no small one, but it need exist only when electric lighting is entirely dependent on machinery in motion. Few persons would be willing to incur the annoyance of keeping their engines at work throughout the night; the great cost, obvious inconvenience, and many disadvantages of any such necessity would stand materially in the way of an extended employment of the electric light; but fortunately the difficulties thus presented can now be overcome. Perhaps I may best illustrate these respective conditions by referring to my personal experience.

My house ranks, I believe, as one of the first, if not the first, in which the electric light was introduced in England, and I naturally have made it so much of a hobby as to use every means to insure success. My experience, however, until I brought storage batteries into use, was, that, to reverse a common saying, "*La chandelle ne valait pas le jeu.*" The annoyance of keeping one of my men night after night to attend to the engine and dynamo, the uncertainty and occasional flickering of the light through the irregularity of the motive power, the inconvenience of only having it available when the engine was running, and the not inconsiderable expense of keeping the whole machinery in motion when only a few lights were required, combined to destroy much of the comfort and pleasure which I had anticipated from the light, and as a matter of fact under these conditions I made but little use of it.

With the introduction of the storage batteries, however, all was changed; the comfort and luxury of the light as now obtained cannot be adequately described. Its absolute steadiness, the facility of regulation to any required degree of brilliancy, the convenience of having it available at any and every moment of the day and night, the economy of consuming only the amount of electricity required for such number of lamps, great or small, as you may wish to have in use, the freedom from constant breakages of lamps through unequality of current, and the many advantages incidental to the employment of the light itself, combined to render the electric lighting of the house a real pleasure of life, such as I believe few who could do so would not be willing to avail themselves of even at a cost double or treble that of gas.

The trouble and expense are reduced to a *minimum*. One of my gardeners starts the gas engine in the morning, attending to his other work as usual, and it runs for such number of hours during the day as may have been rendered necessary by the consumption of the previous evening. Night work can thus be entirely avoided, and a reservoir of electrical power can always be at hand for use by night or day as needed.

For the information of such of your readers as may be interested, I would state that the cost of an installation on this (according to my experience) only perfect system of domestic electric lighting but slightly exceeds that of a system without storage batteries, while the daily economy incidental to the principle of consuming only what you require is very considerable.

The outlay for batteries is practically compensated for by the saving in cost of machinery, which can, under such an arrangement, be considerably reduced in size and power; for example, the power employed by Mr. Coope for running 200 lights would probably be sufficient, with the addition of accumulators, to run from 600 to 800.

I should be happy to go into figures and *data*, but as Mr. Coope's total figures can well be taken as fully representative of the approximate cost of an installation of the kind, such a course is scarcely necessary.

I will only further state that, taking into consideration the indirect saving of expense which the use of this innocuous and beautiful light effects, it costs me considerably less than my previous agents of illumination—candles, oil and gas.

Your obedient servant,
JOHN S. SELLON.

Sydenham Hall, *January 19th*, 1883.

ELECTRIC LIGHTING IN MILLS.

OUR readers will remember that a fortnight ago we notified that a paper on "Electric Lighting in Flour Mills" was read by Mr. Wilson Hartnell before the Convention of British and Irish Millers. An interesting discussion followed the paper, and we publish it under.

The CHAIRMAN said there was no doubt to those possessing corn and flour mills this subject was one of great importance. Probably no manufacture required more light, because they all aimed at running night and day. No doubt there were gentlemen who had experience of both systems of lighting, and he would be glad to hear what they had to say about the matter.

Mr. APPLETON, Stockton-on-Tees, said there were some weak points in Mr. Hartnell's paper, with respect to which he wished to make some remarks. He said that gas was more expensive than the electric light, but that, Mr. Appleton held, would depend upon the price of gas in the particular locality. If they had gas in flour mills near beams, there was no doubt there was danger, but in well-ordered mills gas was not put near beams, but was confined in glass globes, the same as the electric light. He had, however, intended to introduce the electric light into his own mill, but on laying the matter before the insurance company they objected strongly to the wires connected with the lights, as they considered they were dangerous. Another disadvantage of the electric light was that if the motive power was got from the engine of the mill, any stoppages of the engine threw the mill in darkness unless they had storage sufficient for two or three hours.

Mr. BELL, of Messrs. Robey & Co., Lincoln, strongly recommended the incandescent system of electric lighting as the best in use for mills. After the installation the only cost was the renewal of the lamps and the extra steam required to produce the lights. One successful method was to have an auxiliary engine for the electric light. That was very convenient, as it got rid of the difficulty of storage, which was still expensive, and there was always sufficient boiler power in large mills to drive such an engine. By the introduction of a well-organised system of electric lighting, he believed insurance would be reduced to a minimum.

Mr. MARRIAGE, Colchester, said that in that town the corporation had given an electric light company liberty to lay down wires in certain streets, and he understood that those who were lighting their shops and warehouses with the new light paid about double the price of gas. He had intended to introduce the electric light into his own mill, but when he found the price he had to abandon the notion and put gas on the outer walls all round the floors, in lamps similar to street lamps. That answered very well, though of course dust must not be allowed to accumulate on the lamps.

A MEMBER: What is the price of your gas?

Mr. MARRIAGE: 4s. 3d. per 1,000 feet.

Mr. INGLEBY, Tadcaster, said he had had the electric light in use in his mill for 1,400 hours, and only five lamps had burnt out. The cost subsequent to the installation had been 25s., and a portion of the wages of the man who attended to the machines. The driving power was got from a water turbine.

Mr. GREENHILL said the fact that the Colchester company charged for the electric light double the cost of gas was easily explained. In the first place, the electric light, if it was only wanted for a few hours, was not so cheap as gas, and to supply a corn mill, which would require light on an average nine hours a-day, would necessitate the running of the engine when it was not required to supply other parties. Then a company generally wanted to pay a dividend, and they could not supply light as cheaply as a private firm after the first cost of installation. From the experience of some of his clients who had been using the electric light since 1881, he could say that it cost not more than one-third the price of gas. The serious cost at first was the lamps. They used to be satisfied with a much shorter existence of lamps than they were at present, and if lamps came down in price, as they ought to do, he believed the electric light would beat gas supposing it came down to 1s. per 1,000 feet.

Mr. E. APPLEBY, Blackburn, said he had meant to adopt the electric light, but on applying to an insurance company they said that in the meantime they would rather that he did not. He wished Mr. Hartnell to tell him the name of an insurance company which would take a mill fitted up with the electric light at less risk than if it were fitted up with gas.

Mr. GREENHILL said if Mr. Appleby had implicit confidence in the statements made by insurance companies he was about the only gentleman in that position.

Mr. APPLEBY said all he said was that they would not insure for less.

Mr. MOONEY, Dublin, maintained that the statements as to the danger from fire in flour mills had been exaggerated.

Mr. INGLESBY, sen., Tadcaster, held that the electric light was undoubtedly safer than gas. He also found it cheaper, but the price of gas in Tadcaster was 5s. 10d. per 1,000 feet.

Mr. SOUNDY had heard Mr. Hartnell's statement as to the dangers from fire in mills with astonishment. He would like to know what was the great chemical change that had taken place in the wheat berry, since the times when some of them were boys, which created all the danger of which they had been told. They should not let these statements go forth to the world as established facts. They knew there were dangers in mills, but he maintained they simply arose from careless working. The electric light should be advocated on its own merits, and not by urging the great dangers that existed in flour mills.

Mr. APPLETON pointed out that the foreign wheat which was now so largely used, being drier than home-grown wheat, was much more liable to explosion.

Mr. HARTNELL, in replying, said that in going through a mill he saw the danger from fire, and probably exaggerated it, whereas millowners thought of the insurance.

Mr. MOONEY said there was no miller in the three kingdoms who would not do everything possible to prevent fire in his mill.

Mr. HARTNELL further remarked that if the electric light were not properly introduced there was danger in connection with it. What should be done, therefore, was that parties should place themselves in the hands of good firms.

A vote of thanks was passed to Mr. Hartnell for his paper, and a similar compliment was paid to Messrs. Muir & Mavor, who exhibited the electric light.

THE PROGRESS OF ELECTRICITY IN WESTERN AMERICA.

A SERIES of very instructive articles appeared in a recent number of our esteemed contemporary the *Electrical World*, showing the advance being made in various parts of the States in electric lighting and other branches of the application of electricity. The information is supplied by the correspondents of the *World* in six of the most important cities of the Western States.

Commencing with Chicago, we learn that the United States Company had, at the beginning of the current month, just completed an installation of two thousand incandescent lamps in the Home Insurance building. It is stated that the capacity of the plant at any one time is only 700 lights, this number, by the law of averages, being all that will ever be required at once, it is expected. Four dynamo machines and two Porter-Allen engines furnish the current and power.

The new offices of the United States Company in this city were being handsomely fitted up. They are on the ground floor of 216, La Salle Street, in the North-Western Insurance Company's building; they also occupy part of the basement, where it is the company's intention to have all the principal systems of lighting represented, so as to furnish customers an opportunity for comparison. It was also intended to have on exhibition other electric lighting apparatus, and everything would be seen in operation. The company was doing a large business from this office, especially in incandescent lighting.

Mr. Charles Lever, of England, had visited the branch office of our contemporary, and volunteered the information that he was in America for the purpose of interesting capital in his arc lamp, and effecting some arrangement by which the lamp can be manufactured there and put upon the American market.

The Fort Wayne Jenney Electric Light Company had secured the contract for lighting the whole of the Louisville Exposition Buildings, requiring some 500 arc lights. Two hundred of the company's lights at the New Orleans Exposition were to be shipped to Louisville, to form part of the installation. The Jenney Company had also sold to the Louisville Exposition 46 lights for permanent use in the music hall.

In St. Paul, Minn., current had just been turned on for 20 Western electric arc lights, to illuminate Dickinson's grand bazaar.

Crawfordsville, Ind., and Adrian, Mich., were each going in for electric lighting to the extent of 30 Thomson-Houston arcs.

The Van Depoele light had been introduced at Flint., Mich., and Fort Smith, Ark., 36 lights on nine towers being employed at the former place.

Professor John Barrett, the city electrician, had just reported that the present head-quarters of the city telegraph in conveniences, equipments and furnishings are unsurpassed by those of any similar institution in the world. Within command of the general public, in case of fire, there are situated at the most needful points, and in the most accessible positions, 514 stations or boxes, having direct communication with the fire-alarm office. In addition there are 434 public and 332 private police boxes, making altogether 1,286 stations through which assistance from the fire department may be summoned. The entire underground system comprises 7,931 feet of conduit, 4,872 feet of iron pipe, 5,760 feet of cable, and 36¼ miles of single wires, the total mileage of aerial fire-alarm wire being 358.

At Cincinnati the status of the electric light was said to be fair, there being 500 arc lights burning nightly, with a sprinkling of incandescents. The Brush people do nearly all the public lighting, their plant occupying the whole of a three-story brick building. This plant has a capacity of 440 lights, and was running 350. There were ten dynamos, with the improved armature, the taper sleeve pulley being exclusively used. Something out of the usual line in switch-boards is in use there. It is what might be called a hook-board instead of a plug-board, and by its use the current is never entirely broken. If it is desired to couple two or three machines together, instead of pulling out a plug here and inserting it there, one of the connecting cords, with an eye on either end, is picked up, hooked on to a hook at one end, and the other end held against the other cord, the two or three being then carried to the proper hook, and the connection made without breaking the current.

There is no city lighting done in Cincinnati, the 350 lights being rented out to business houses. There are ten circuits, and the

district lighting is embraced between Central Avenue and Broadway, and Fourth Street and McMicken Avenue; and within these boundaries there are some very fine displays of arc lighting, notably the one on Fifth Street, between Walnut and Vine, the small square here being fringed by as brilliant a circle of lights as is anywhere to be seen. Outside this plant there are over 100 arc lights in isolated plants. The United States Company and the Thomson-Houston were represented in these plants.

One of the river steamboat lines, of six boats, is fitted throughout with electric light, arc and incandescent.

The Cincinnati telephone exchange has 2,700 subscribers, who are served through five exchanges. The old Jones switch-board is used, and to attend to these 2,700 subscribers 108 operators are employed, this number including night, day, and relief forces. Through the main exchange 700 subscribers are answered; 18 of the Jones boards are used here, and 18 operators and two reliefs are employed. Through toll lines 300 towns can be reached from Cincinnati. Notwithstanding the fact that the multiple board is not in use, the telephone service in Cincinnati is very good. The penalty of using old apparatus, in the view of our contemporary's correspondent, falls more upon the telephone company than upon the subscribers. What delay there is with the use of the Jones boards results from the necessity of having to pass checks from one table to another. The check boy is the busiest person in the exchange, and has to be relieved every hour. People seem very well satisfied with the service, and the business is increasing quite rapidly, the net gain in the month of April being 51 subscribers.

Mr. Edgar A. Edwards, inventor of the dynamo bearing his name, is said to be developing a complete system of electric lighting, including dynamos, lamps, current regulators, &c. A feature of the system is described as a most excellent locomotive head-light outfit, details of which are not yet published.

The Waldumer electro-magnetic brake system is being perfected in Cincinnati. It consists of a combined engine and dynamo located upon the right side running board of the locomotive, with the conductors, couplings and brake-actuating mechanism, in addition to which are the relays, switches, annunciators, signals, &c., for producing special effects. The engine and dynamo are kept running constantly at a low rate of speed to furnish a constant current for the closed circuit, which keeps the automatic brake and danger alarms out of action, and is used in lieu of the bell cord for communication between the engineer and conductor. The main brake circuit is in multiple to avoid high electromotive force and to insure complete circuits on each position of the parted trains. In applying brakes from the engine a switch-lever is moved, connecting the brake circuit with the dynamo, and sufficient current flows to take up the slack and to set the brakes lightly; increased braking power is then obtained by opening the throttle valve of the dynamo engine gradually or suddenly, as circumstances require, the current and braking power being proportional to the speed of the dynamo. This is what is known as the "straight brake," in which all the power is transmitted from the locomotive to the brakes direct, and insures absolute uniformity and regulation of power. The brakes may also be applied from the engine or any of the cars by breaking the normally closed circuit, which also occurs in the event of the separation of the train. This action is the electrical equivalent of that of the automatic air brake, and, like it, lacks the uniform application and graduation of power of the "straight brake." For connecting the conductors between the cars, couplings having concentric contact surfaces are used. This secures the connection of corresponding wires under all conditions, while a quarter turn in making the coupling produces clean surfaces. The uncoupling of the conductors is automatic, without injury to the wires. The action of the brake is prompt, both in application and release, and sensitively responsive to variations of power required. A strong company has been organised to push this brake, and future developments will be looked for with interest. The brake has been tested on a number of roads, and the trials so far are said to have been very satisfactory.

The correspondent at Detroit writes:—Although Detroit has been a silent partner in the business of booming electrical interests, it does not necessarily imply that we are behind in actual advancement of and interest in electrical development. We have in our beautiful "City of the Straits" no less than seven different systems of electric lighting, a large telephone exchange, two electrical works, an electric tower company, and an experimental electric railway; and I believe we have the honour of being the first city in this country lighted entirely by the tower system.

The first system of electric lighting to be sprung upon our unsuspecting public was the "Brush," by the Brush Electric Light Company, of Detroit, which has given Detroit the name of being the most perfectly lighted city in the universe.

The Brush Electric Light Company of Detroit, was originally incorporated in 1880, beginning its existence as a light dispenser with 16 Brush lights on September 10th of that year. In 1881 W. W. Leggett bought the whole interest, and during the year reorganised under the new law, with $100,000 and 32 lights. A station was built, 46 feet by 100 feet, with two Wright-Corliss engines of 200 H.P. each and a nest of three boilers. In 1882 the lights had increased to 150 and in 1883 to 260, when it was found necessary to add 46 feet by 100 feet to the plant, build two stories high and to put in a 350 H.P. Cummer engine, with a nest of four boilers, as well as a Ball engine for running one machine on day circuit. From July, 1883, to July, 1884, the company lighted two avenues with 26 lights. In June of the same year they erected an experimental tower 150 feet high and captured the contract for lighting the entire city, displacing two gas and one naptha companies. The contract called for 72 towers, 66 of which were to be 100 feet and 6 to be 150 feet high, and to employ 290 lamps, for the sum of $95,000 per year. Finding more towers and of greater height desirable, the company, without consideration, increased the number to 90 towers, of which 87 were 150 feet and 3 were 175 feet high, supplementing these with about a dozen post lights erected in dark places, aggregating about 400 lamps in all. The area lighted comprised the entire city to its limits, or about 12 square miles.

In the dense business section of the city the towers stand about 1,000 feet apart, the distance increasing to 1,500 feet or 2,000 feet, until at a distance of 1½ miles from City Hall, after which 2,500 or 3,000 feet is the usual spacing. They are arranged in triangular order as nearly as possible, so that every point distant from a tower shall have the light from at least three towers to blend over it. The towers employed are those made by and patented to the Detroit Iron Tower Company, of which Mr. Leggett is also president. These towers are very compact, and are entirely free from the objection of occupying too much space, standing as they do upon a single 14-foot pillar, occupying only the space of an ordinary lamp-post. Above this pillar rises a prismatic tower of iron-triangular in cross-section, with steps up one corner, and an elevator in the interior, by which the attendant rises to the top. The towers are supplied with a platform just above the pillar, where the attendant enters the elevator, and another at the top, both guarded by high hand rails. At the top the tower has a mast with radiating arms, upon which the lamps are supported.

Two of these towers employ six lamps each, three employ five lamps, and the remainder employ four lamps each, the usual 2,000 candle-power Brush lamp being used throughout. These towers are stayed by two independent sets of galvanised wire cables leading from their tops, generally to one set of strong white oak guy-posts standing vertically 6 feet in and 9 feet out of the ground. The company now operates about 700 lamps, has a nominal capital of $300,000, with $215,000 paid up and issued. Its plant, including towers, represents about $280,000.

The following, signed by 19 of the leading physicians of the city, demonstrates the satisfaction generally felt with the lighting by electricity:—"We, the undersigned practicing physicians in Detroit, and having frequent occasion to visit all parts of the city during the night time, in all kinds of weather, have found the city well lighted by the tower system of electric light. We find the streets, yards, alleys and public spaces lighted as if by moonlight, and have no hesitation in saying that Detroit is by far the best lighted city that we know of; is incomparably better lighted than ever before by gas or naptha, and we hope there may be no return to the former régime of lighting."

In Indianapolis the electric light is said not to make a good show, on account rather of the absence of any large and compact plants than of the scarcity of lights in proportion to the population. The town itself is spread over a large area, and really contains over 250 arcs. Here, as at Cincinnati, the principal business is done by the Brush representatives, who have the contracts for all the public lighting, and, with but one stated exception, all the private installations. The exception is a Jenney plant of 17 lights in the "When Clothing Store." In the Brush station, located at the corner of Pennsylvania and Georgia Streets, there are six dynamos furnishing a current for 150 lights nightly. The engine used is an Atlas Corliss engine of 150 horse-power. Most of the dynamos have the new improved Brush armature. These 150 lights are rented out to business men within a very large district for so small a number of lights. Probably the finest isolated plant is the one at the Pan-Handle shops. This is a recently installed plant of 40 lights, and the latest Brush apparatus is used throughout. There are, besides the above, enough isolated plants around the town to bring the whole number of arc lights in the city up to somewhere between 250 and 260. There are but a few incandescent lights in Indianapolis, these being at a couple of the hotels.

The Indianapolis Telephone Exchange has 1,025 subscribers. Twenty operators are employed, which number includes the night, day and relief force. The day force is usually thirteen operators. Six and-a-half sections of multiple switch-boards are used, the capacity of the boards being 2,400, and the present equipment 1,200. They have recently adopted "Head telephones" in this exchange, and they are giving entire satisfaction. The Head telephone used is simply the old "Pony Crown," with the addition of a straight magnet and a head band, the head band being insulated from the magnet. There are 18 toll lines coming into Indianapolis, by means of which 135 towns are reached. The telephone service in Indianapolis is reported to be all that could be desired.

The rate charged here to subscribers is $60 a year for business houses within half a mile of the exchange and $50 for residences within three-fourths of a mile, with an additional charge for greater distances.

By means of a tower chart they avoid the necessity of testing any particular line they may wish to examine in the tower. The chart is a book, in one column of which the switch-board numbers appear in consecutive order. Opposite each switch-board number in the chart is the tower number of that line. The lines entering on each side of the tower are also numbered in consecutive order. Suppose something is the matter with a certain line, the operator ascertains the switch-board number, and by consulting the chart is enabled to find the line in the tower immediately and without trouble.

The operating room of the Western Union Telegraph Company's

office at Indianapolis is a room 55 feet by 60 feet, and is lighted by 19 windows. The operating force numbers 38, four of whom are ladies; with this force 39 circuits are looked after. The room is fitted up with 13 black walnut tables for eight instruments each, and seven quadruplex sets, three Stearnes and two polar duplex sets, seven sets repeaters, and 44 single instruments are in use. A switch-board for 130 wires, with 92 wires, is in use. In the battery room—dimensions 60 feet by 70 feet—there are 3,800 cells Callaud battery.

There seems to be some opposition to electric lighting in Kansas City, based on the theory that the city is so hilly and broken that the rays would encounter some obstruction, an adequate distribution of the light being thus prevented. The writer of our contemporary's article, however, believes that a more careful consideration would establish an entirely opposite conclusion. A few dozen lights, he thinks, placed on the most prominent eminences would produce a pleasing effect and a satisfactory result.

The Kansas City Electric Light Company, which uses the Thomson-Houston system, has in operation about 220 lights, only a small proportion of these, however, burning the entire night. The company has recently submitted to the city council a proposition to light certain of the streets and avenues, for which about 100 lamps would be required, and these the company proposed to furnish, erect and operate at the price of 55 cents per night. The president, in making the proposition, said the lights would be of 2,000 standard candle-power each, and would be lighted all night throughout the year.

Three years ago the Brush Electric Light Company of Cleveland succeeded in obtaining a contract for lighting La Fayette, Ind., by means of five 4,000 C.P. lights on a mast 175 feet high, the contract being for two years, 2,400 hours of light per annum, and the consideration $2,500 per year. These lights cut out an average of 100 gas posts each, for which the city had been paying $37 each per annum, thus saving the city a handsome margin. At the expiration of the term of the contract a local Brush Company was organised, and made a spirited attempt to get the city lighting, which had cost the city previous to the introduction of the electric light from $12,000 to $16,000 per annum. The gas company is supposed, however, to have manipulated a certain committee chairman, as the contract for three years was awarded to the gas company at about $8,000 per annum, notwithstanding the fact that the electric light company bid $400 less than this, and would have given the city from five to ten times the amount of light it now has. There is an opinion prevalent that there will not be a repetition of this gas contract, even at the reduced price, which is about $25 per post. The complaints are numerous that the amount of glimmer emanating from these so-called lights has been made to conform to the reduced price of "the stinking stuff."

Numerous electric lights are hung over the centre four streets, which are paid for by the merchants doing business in the vicinity. The company has four arc lights in each of the skating rinks, and is now wiring the opera house for both arc and incandescent lights. It has been running a 45 arc light Brush dynamo, and is at present erecting a new station in the centre of the business portion of the city, putting in high-speed Buckeye engines, flange steel tubular boilers, Dayton duplex pump, Baraguanath heater and Shaffer and Budenberg exhaust injectors. This little plant is to be first-class in every detail, and when in, a 60-light direct incandescent Brush dynamo will complete the outfit.

THE INVENTIONS EXHIBITION.

AT Messrs. Paterson and Cooper's Stand, No. 1,292, are exhibited several of their latest types of "Phœnix" dynamo machines for arc and incandescence lighting and for electro-plating. These machines are made, some with wrought iron field-magnets, and some with cast iron magnets, and are of several different types, according to the purpose for which they are designed. The armature of the machine is constructed of Paccinotti-like plates of wrought iron of the softest quality, the wire being wound in the slots, two coils in each. The plates are carefully insulated from each other by sheets of paper, and the whole armature firmly braced together by insulated bolts passing through the armature from end to end. In construction the object has been to obtain a substantial and strong mechanical connection between the armature and the spindle consistent with completely insulating every part, where an absence of this precaution would tend to the generation of wasteful Foucault currents, and Messrs. Paterson and Cooper have they believe in the "Phœnix" machines succeeded in gaining their object. The machines are of strong, substantial design, see REVIEW for May 17th, 1884, and all built to do heavy work, and with due regard to durability. At this same stand are on view the "Phœnix," the "Clark-Bowman," the "Pilsen," and the "J. F." arc lamps, for all of which the firm acts as agent. The selection of measuring instruments shown here is very complete. Some Wheatstone's bridges, resistance boxes and reflecting galvanometers of excellent workmanship are exhibited, as well as the ordinary line testing instruments employed by workmen. A good assortment of Ayrton and Perry's ammeters and voltmeters is shown, but these instruments are so well known as to call for no special description here. It might just be mentioned *en passant* that all instruments now made by this firm are calibrated direct in ampères and volts, and that the deflections are always proportional to the current flowing. Paterson's electro-magnet ammeter is an instrument which may probably be new to some. In this

FIG. 1.

FIG. 2.

instrument the permanent magnet is replaced by an electro-magnet, which is magnetised by the current which deflects the needle. In the interior of the instrument is an electro-magnet, consisting of a bundle of soft iron wires carefully annealed, and

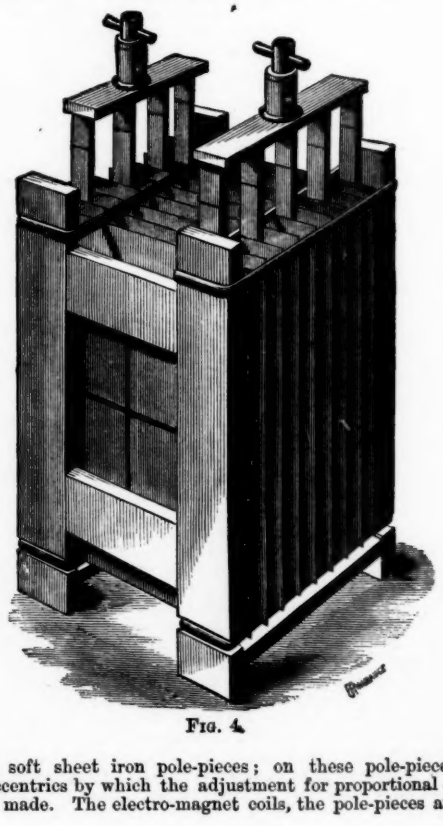


FIG. 4.

having soft sheet iron pole-pieces; on these pole-pieces are fixed eccentrics by which the adjustment for proportional deflections is made. The electro-magnet coils, the pole-pieces and the

galvanometric coil are fixtures on the dial plate, but the bundle of wires can be slid through both the coils and the pole-pieces, by which means the adjustment for direct reading is obtained. When the adjustment is completed the wires are secured in place by a tightening screw. Fig. 1 shows two of these instruments, an ammeter and voltmeter combined, in one case, and forming a very convenient and portable testing arrangement. The voltmeter invented by Captain Cardew and illustrated in the REVIEW for December 29th, 1883, now that some hundreds are in use, can scarcely be considered a novelty, but its action may be here briefly described. The voltmeter consists essentially of a fine-platinum silver wire, one end of which is attached rigidly to one of the terminals of the instrument, and the other to a staff or pulley, which by its rotation indicates the amount of expansion the platinum wire has undergone due to the passage of the current through it. A certain difference of potential at the terminals of the wire gives a certain expansion, and a needle fixed on the staff indicates the difference of potential on a dial calibrated direct in volts. These instruments can be kept on the circuit continuously, as the heating by which in galvanometric voltmeters the efficiency of the instrument is impaired is

FIG. 3.

here employed to produce the indications. Having no coiled wires the error introduced due to self-induction is not found in these instruments, and they can consequently be employed for alternating as well as continuous currents. A fuse of very fine wire is placed in the instrument to prevent fusion of the working wire, should the difference of potential at the terminals of the instrument exceed the working limit. Several of Paterson's engine room ammeters are shown, and also Paterson-Joel ammeters, as illustrated in our pages for May 5th and September 22nd, 1883. In these instruments the galvanometric coil is replaced by a single strip of copper. Instruments of a simple form for rougher work are also exhibited at this stand (fig. 2). Messrs. Paterson & Cooper also exhibit a number of ornamental fittings and shades for incandescence lamps, along with all the necessary apparatus and accessories required for fitting up installations, such as the well-known Eidsforth (fig. 3) and Maynard switches, fuses, fuse holders, lamp holders, &c. A selection of Wallace Diamond and other carbons employed for arc lamps is also to be seen. A battery of 20 Joel accumulators is shown, and in this accumulator it is claimed that the principal difficulties which have been incidental to the use of accumulators in the past have been overcome. The positive and negative electrodes are firmly braced together in a wood frame, and are quite independent of the cell or box in which the dilute acid is contained. They can therefore be lifted out and inspected at any time. The electrodes are shown in fig. 4. Joel's patent adjustable resistances for use in electric lighting is also shown, this being first illustrated in the REVIEW for May 12th, 1883. Several of Prof. S. P. Thompson's electro-motors are exhibited, and also Thompson and Starling's patent universal photometers for measuring the candle-power of incandescence or arc lamps. One form of the photometer is shown in fig. 5. It consists of a graduated bar, at the centre of which are fixed, back-to-back, two opaque screens, attached to one another at a small angle. On one screen falls the light which is to be measured; on the other falls the light from two standard candles of spermaceti. By adjusting the relative positions of the candles and of the light whose intensity is to be measured the relative intensities are ascertained, and the scale marked on the bar of the photometer is so marked as to reduce the calculations to a minimum. When the instrument is employed to measure the candle-power of arc lamps it is set on a tripod, and a mirror is employed to throw the light from the lamp directly on to the screen. In addition to these exhibits the firm has here several specimens of their electro-deposition of metals, including zinc, brass, copper and tin deposited on iron; nickel on iron, brass and copper; silver on iron, copper and brass, &c. A small dynamo used for electro-plating is shown, which is capable of depositing 5 lbs. of nickel per day. Side by side with this is a machine for copper refining, which is capable of refining 5 cwts. per day. Machines are constructed by the firm capable of depositing one ton of copper per day. Photographs of most of the machines made by the firm are exhibited, which vary in size from machines for 10 20-C.P. lamps to machines for 1,000 20-C.P. lamps. Many of the machines have been made for special purposes, and several are working continuously with the greatest success in different parts of the world.

(1394.) One of the most creditable and striking exhibits in the arcade is the arrangement of glass cases which contain samples of the work turned out by Messrs. Davis and Timmins, Limited screw manufacturers and metal merchants of Bowling Green Lane, Farringdon Road. The specimens comprise an immense variety of screws, nuts and turned parts of all sorts and sizes for dynamos, electric lamps, telephones, electric bells and instruments. There are also samples of chrome-bronze conductors for the transport of electricity to great distances, arsenical bronze having a resistance of 600 ohms per kilom., diameter 1 mm., and T. O. Mouchel's copper wire possessing a conductivity of 100 per cent., (?) for which Messrs. Davis and Timmins are sole agents.

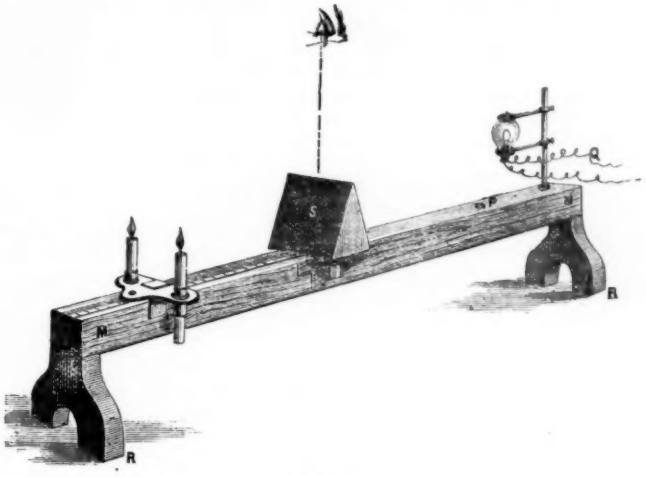


FIG. 5

LEGAL.

Lancashire Maxim-Weston Electric Company, Limited.—In the Chancery Division of the High Court of Justice on the 26th ult., Sir James Bacon had before him a motion on behalf of the voluntary liquidators of the Lancashire Maxim-Weston Company for the opinion of the court as to the claim of Admiral Sir E. Inglefield for payment at the rate of £1,000 a year to him as director under the articles of association. The directors, by a subsequent agreement, as the capital of the company was only £14,000, had agreed to pay the chairman £2 2s. and the directors £1 1s. for each meeting they attended. Mr. A. Young, for the liquidators, asked for the opinion of the court. Mr. Buckley, for Sir E. Inglefield, said that £1 1s. was only part payment of an instalment of the £1,000 a year. The Vice-Chancellor said that the directors had agreed to accept £1 1s. for each meeting that they attended, and that Sir Edward Inglefield was entitled to £1 1s. for each meeting and no more, the costs to come out of the estate.

Telephonic Development in Cumberland.—The West of Cumberland, which has hitherto been, telephonically speaking, "no where," has been taken in hand by the National Telephone Company with great energy. Until a few months ago Cumberland lay within the territory of the Northern District Telephone Company, but a transfer to the "National" having been arranged, that company proceeded to open up the district, which, with its iron and steel works and coal and hematite ore mines, is eminently adapted for telephonic communication. The first fruits were evidenced on June 26th, when the exchanges at Whitehaven and Workington, with a trunk wire between those towns, were opened for traffic. Many of the principal firms were on that day placed in instantaneous communication with each other; and others will be added as fast as the wires can be constructed. The company have also taken contracts for exchange connections in Frizington, Cleator Moor and Maryport, which towns are to be connected to Whitehaven and Workington forthwith.

C

REVIEWS.

Domestic Electricity for Amateurs. Translated from the French of E. HOSPITALIER, with additions, by C. J. WHARTON. London: E. and F. N. Spon, 125, Strand.

We have so recently (Feb. 21st, 1885) had occasion to review the original French edition of this work that a lengthy notice of the English edition of the same is unnecessary. Mr. Wharton has done the work of translation well, and such additions as he has made are on the whole judicious. It remains only to be added that Messrs. Spon have shown their usual excellent judgment in the "get up" of the volume.

Wrinkles in Electric Lighting. By VINCENT STEPHEN. London: E. and F. N. Spon, 125, Strand.

The intention of the author of this small volume is to give engineers on board ship, who may be put in charge of electric lighting machinery without having any electrical knowledge, some idea of the manner in which electricity is produced by mechanical means; how it is converted into light; what precautions must be used to keep the plant in order, and what to do in the event of difficulties arising. The book is written in a colloquial style and is decidedly deserving of commendation. The matter is mostly thoroughly practical and to the point. We note a good suggestion on page 43, viz., that switches of the incandescent lamps should be painted with Balmain's luminous paint, so that there would be no trouble in finding them in the dark.

Primers of Electricity. By Prof. E. J. HOUSTON, and Others. Second edition. London: published at the Office of *The Electrician*, 1, Salisbury Court, Fleet Street, E.C.

In the series of short papers of which Prof. Houston is the author, much information suitable for a primer is given, but at the same time a considerable portion of the information is dealt with so extremely briefly as to be practically perfectly useless; thus we have dynamo-electric machines considered on four pages of large print, of which one page is taken by two illustrations, neither of which would afford the slightest insight on the subject to those who would be likely to study the primer. Article No. 12 on the storage battery, brief as it is, is overburdened with most unnecessary extraneous matter. The article which follows, viz., "The Electric Telegraph," being written by an American, not unnaturally describes the American closed circuit system of working; considering, however, that the primer is an English publication, written, we presume, more especially for the benefit of our own countrymen, the description of a system practically wholly unknown in this country is, to say the least, a mistake. Article 16, on "The Transmission of Energy," is decidedly weak. Coming now to the portion of the volume written by "Others," we come to a portion which is by no means satisfactory. We are first informed that the "astatic galvanometer" was invented by Sir William Thomson. In article No. 29, on "Ohm's law," we are told "if we take a galvanometer (G), a battery (B), a wire resistance (R), and send the current from the battery through the wire and the coils of the galvanometer, the needle of the galvanometer will be deflected and a certain current will pass through the coils of the galvanometer. If now the wire . . . . be doubled in length, all other things remaining the same, the current through the coils, as shown by the galvanometer, will be halved." Not a word is said about the resistance of the galvanometer and battery, nor is there the slightest indication to lead the reader to assume that it is supposed to be negligible; indeed, any reader who has gone through the previous articles, in which a galvanometer of 5,000 ohms, and a battery with a resistance of 2 ohms per cell is spoken of, is hardly likely to assume that these resistances are supposed to be zero in the articles which follow.

NOTES.

Lighting of Covent Garden Theatre.—The Jablochkoff Company is about to light Covent Garden Theatre for the promenade concert season with 50 arc and 400 incandescent lights. The installation will be worked from a shed adjoining the Floral Hall, and the steam power will be supplied by two of Messrs. Hornsby and Sons' new compound engines. The fact that the Jablochkoff Company, which carried out this lighting two years ago, has again secured the contract, is in itself a testimonial to its good work.

Electric Lighting at Kimberley.—A fancy dress ball was recently given by the Mayor of Kimberley, South Africa, the arrangements for which included the lighting of the Theatre Royal, in which the ball took place, by electricity, under the direction of Mr. Cousens, who installed five arc lamps, depending from the roof, and 38 incandescent lights, distributed in the form of arches over the various entrances. Mr. Cousens created a sensation by getting himself up as Aladdin, of "wonderful lamp" fame. The Kimberley *Daily Independent* thus describes his appearance: "In the orthodox blue silk costume that is Aladdin's dress by common consent, he was conspicuous enough, but when to this is added a brilliant dazzling altogether too too incandescent light on his turban that was flashing all over the place, he was more than conspicuous. The idea was certainly a clever adaptation of electricity."

The Electric Light in Naval Warfare.—The electric light played an important part in the naval evolutions in Bantry Bay this week, the force attacking Rear-Admiral Whyte's position on Monday night being completely nonplussed, so the papers say, by the dazzling rays from the ships.

Electric Lighting in Mills.—Mr. Wilson Hartnell has done good service in bringing the advantages of electric lighting so prominently before the Convention of British and Irish Millers. Doubtless many mill-owners will benefit by acting upon Mr. Hartnell's remarks.

To Electric Light Contractors.—For lighting the borough, either by gas *or other means*, for one or three years, at the option of the Council, from 1st September, for the Council. Specifications as to lighting by gas or by mineral oil may be seen, and forms of tender obtained, at the Town Clerk's office, Poole. Sealed tenders, endorsed, marked "Tenders for Lighting," to be sent in conformity with specification to the Town Clerk by 6th inst.

Electric Lighting and Colliery Explosions.—Lord Thurlow has written to the *Times* as follows upon this subject: "It is to be hoped that your remarks on the Clifton Hall Colliery explosion will open the eyes of the Home Office, the Board of Trade, colliery owners, and all concerned to the necessity of making electric lighting compulsory in all coal workings. No mechanical or scientific difficulties exist, and no special lamp has to be invented, as the ordinary 20 candle-power incandescent lamp is perfection for the purpose. A small first cost need only be incurred, and a direct and immediate saving would be effected, the cost of electric lighting being less than one-half that of oil, with ten times the efficiency, besides not vitiating the atmosphere, to which advantages add the future absence of periodical explosions in "fiery" pits, which, you tell us, have cost this country 40,000 lives and over a million of men injured during the last 30 years—not taking into consideration the support of their widows and orphans. I will not ask for more space to-day, or I might urge the almost equal claims to electric lighting of flour, cotton, and other mills where the atmosphere is charged with combustible or highly inflammable dust."

Telephonic Charges on the Continent.—A correspondent of the *Financial News* supplies the following comparison of telephone charges in different cities and towns of the continent :—

Hamburg, Germany.....	marks	150	or	£7	8	0
Altona, Germany	marks	150	or	7	8	0
Lubec, Germany	marks	150	or	7	8	0
Kiel, Germany	marks	150	or	7	8	0
Berlin, Germany	marks	150	or	7	8	0
Basle, Switzerland	francs	150	or	6	0	0
Brussels, Belgium	francs	250	or	9	18	0
Ghent, Belgium	francs	200	or	7	18	1
Charleroi, Belgium	francs	225	or	8	18	6
Verviers, Belgium	francs	200	or	7	18	1
Antwerp, Belgium	francs	250	or	9	18	0
Amsterdam, Holland	florins	120	or	10	0	0
Arnheim, Holland	florins	80	or	6	13	0
Enschede, Holland	florins	30	or	2	10	0

The writer adds :—"I have placed the Enschede at the bottom of the list ; it is a remarkably low charge, and notwithstanding the company has only 150 subscribers, and notwithstanding some of the distances are more than 2½ miles apart, the company, which is admirably managed, and which is a private one, pays its shareholders and fully depreciates for wear and tear. And furthermore, if any member or shareholder of the Enschede Company wants to have the telephone laid to his private villa (sometimes a long way from the town) the company undertake the contract at a charge of 2s. 4d. for the 100 metres, or 130 yards, inclusive of poles and wire, and after one payment of this charge the whole, wire and all, belongs to the subscriber."

The Boston Telephone Conference.—This is the view taken of the conference of telephone people which we recently announced was to take place at Boston by the *Electrical Review* of New York :—"The much talked of conference between the American Bell Telephone Company and a few of its licensees, held in Boston last week, as noticed in our last edition, was hardly what the invited guests expected. First, as regards the relation of the parent company to the sub-companies in the matter of rentals to be paid, and this was really the only important matter before the parties in interest, the action of the Bell Company was to an outsider quite liberal, but not to an insider who knows the situation. The proposition made by the Bell Company was really a step taken in its own interest. The conference almost immediately after assembling, had read to them a letter from the Bell Company, which announced that a reduction would be made. Such a reduction was necessary in order to keep the instruments in use, as the places affected would have to discontinue business if the present rates continued. It is possible the sub-companies will find that the general impression among their subscribers is, that they have had a material reduction made in the price paid for instruments, and that a corresponding reduction should be made to users, while the fact is but a small reduction has been made, and it affects only a comparatively few subscribers who are now paying minimum rates. The whole affair was made an occasion for the parent company to show its licensees a little hospitality, and to try and create a little good feeling, which is much needed at the present time."

The International Telephone Company, Limited.—The *Financial News* states that there has been considerable fluctuation lately in the shares of the International Telephone Company of Paris, mainly on account of difficulties which have arisen respecting the concession for Paris. The company has applied for a prolongation of the concession, and the Municipal Council has protracted the negotiations. Finally, the council has voted the renewal in principle, but "without prejudice to the right of the City to establish and work a system of its own or to admit competitors." Meanwhile, the Minister of Posts and Telegraphs has accorded a rival concession demanded by M. Dauderin, who proposes to carry the wires along the subterranean sewers of Paris.

The Telephone in Inverness.—We have received the June issue of the National Telephone Company's list of subscribers for the Inverness district, and note gratifying progress since the beginning of the year. The population of the town is 17,000, and it is chiefly a place of summer resort. The central office was only opened in the beginning of the present year, with a membership of 42, and four call offices. The efforts of Mr. Townsend, the district manager, have since then been instrumental in procuring 16 new subscribers and opening another call office. As an instance of the good use to which the subscribers put their instruments, we may state that last week no fewer than 4,000 messages were transmitted, an average of over 600 per day.

Telephones.—In a future issue, probably next week, we hope to describe and illustrate a system of telephony in which the transmitter is said to make and break contact. So far as we can see, however, the inventor is mistaken with respect to the transmitter action.

The United Telephone Company.—It is rumoured that Mr. J. B. Morgan is about to vacate his position as managing director of this company. The Lancashire and Cheshire Company is mentioned as the future field for his operations, and a very influential gentleman is indicated as Mr. Morgan's probable successor in London.

The Telegraph in Afghanistan.—The correspondent of the *Times* at Calcutta says that in connection with the question of improving the trans-frontier sources of information, it has been pointed out, and he considers the suggestion well worth attention, that no time should be lost in extending the telegraph to Cabul.

The Telegraph in Central Asia.—It is announced from St. Petersburg that telegraph offices have been opened at Karibent, Rukhnabad, and Merv.

Cable Repair.—The Eastern Telegraph Company announces the re-establishment of communications *viâ* Suez with India, China, and the far East, by the repair of the Aden-Bombay cables.

Atlantic Cable Rates.—It is reported that as soon as the break in the American cables is repaired the Western Union will announce a general reduction in the tariff between New York and London to 6d. per word against the present rate of 40c. per word. The Bennett-Mackay cable is said to be getting most of the Wall Street business now, and this reduction is designed to bring it back to the old companies.

Central and South American Cables.—There were rumours recently, in connection with the disturbances in Central America, of the military occupation of the cable stations, and the suppression of telegrams not approved by the authorities. Correspondence in our American contemporaries, however, has elicited the fact that the United States Government took measures to prevent any interference with through international telegraph messages or diplomatic dispatches.

The Cable Ship "International."—The ss. *International* left Port Said for Malta on the 26th ult., with 41 invalids on board, on her homeward voyage.

Something like an Accumulator.—A friend informs us that he and another well-known engineer were struck by the advertised large storage capacity of a secondary battery at the Inventions Exhibition. Desirous of knowing of what the plates were made, they examined the apparatus closely, and found them to be *painted wood.*

Personal.—Mr. J. Fletcher Moulton, F.R.S., who, as we announced last week, has been adopted as the Liberal candidate for Clapham, is now a Q.C., this honour having been conferred upon him a few days ago.

Signs of the "Times."—The scientific representative of our leading daily, who apparently does not advance with the *times* so far as electricity is concerned, speaks of the Jablochkoff primary battery thus :—"It would appear to meet the objections present in most primary batteries without having any of its own, so far as present experience has shown." The same was said in various quarters respecting Jablochkoff's electro-motor, but who can inform us where even one of these motors has been practically employed? We learn from the same eminent authority that a company is working the invention in Paris, where the batteries are being manufactured and are coming largely into use. So much the better, if true, for M. Jablochkoff, for we do not anticipate a similar result in this country. The very fact that "short and frequent intervals of rest are necessary for the battery to re-form itself for the production of the useful current," is in itself such a high recommendation.

The Edison Electrical Meter.—Some facetious remarks, relative to the vagaries of an Edison meter which had been contaminated by the evil influences of a gas meter with which it was associated, having gone the round of the technical press, a warm defence of the electrical instrument, from a "Circleville Meter-Man," will be found in our Correspondence columns.

Secondary Batteries.—Mr. F. Geere Howard's reply to the voluminous correspondence which appeared in our last issue is more noticeable for "twits" upon his critics than for any real defence of his hurriedly-compiled paper. A compilation of twelve months since should scarcely be published and distributed now as containing authoritative information on a new invention which since that time has been, and is being, improved upon.

The Wimshurst Influence Machine.—We have received from Messrs. J. T. Mayfield and Co. an intimation that a large number of these machines are being made by the firm, and that they will shortly have one ready for constant exhibition at their showroom.

The Etiquette of Legal Proceedings.—In our last issue we alluded to a pending trial respecting an electric lighting installation. For this we have been called to task, by a gentleman who shall be nameless, but who evidently writes without due consideration. He gives us the extraordinary information that it is unusual, while a case is pending, to *refer to it.* We are aware that comment is hardly justifiable in such cases, but that reference also is to be omitted is news indeed.

Arc Lamps and Carbons.—We shall be pleased to publish the opinions of our experienced readers anent the reports on arc lamps and carbons used in the Philadelphia Exhibition, published in our issues of the 20th and 27th ult. The Boulton carbon appears to considerable advantage, but we are not aware that it has yet been employed to any extent in this country.

Electric Lamps for Mines.—Mr. Ellis Lever having again offered a premium of £500 for the best portable safety lamp for mines, electric or otherwise, we shall be glad if Mr. Lever or any of our readers can inform us what conditions are attached to the competition, in order that we may publish the same for the benefit of intending competitors.

Berne Administration.—Mr. Emile Eschbacher, who has for a considerable time held the position of "Chef du Bureau" at the French Ministry of Posts and Telegraphs, has been appointed to the post of Secretary to the International Administration of Telegraphs at Berne, which office became vacant by the death of M. de St. Martial. Those who know most of Mr. Eschbacher will recognise his especial fitness for a post where tact is not the least necessary qualification.

The Grosvenor District Electric Supply.—Rapid progress is being made with the work at the above central station, and towards the end of the present month a start will probably be made. Messrs. Marshall, Sons & Co., Limited, have delivered the three 40 N.H.P. boilers, and two are now in position, whilst the large engine is nearly erected, and the other two will also shortly be in a condition for running. Messrs. Siemens Bros., who are building the main supply dynamos, have succeeded in completely stopping the "*hum*" which was so noticeable and objectionable a feature in their alternating current machines. A large chimney shaft, 110 feet high, and having an internal area of 36 square feet, has been erected and is now complete. This shaft has been made large enough to be suitable for two such plants as are being put down, with a view to immediate future extension should the present one succeed. As regards this success Messrs. MacKenzie & Brougham, the engineers to the scheme, are now perfectly confident, the small 500-light temporary installation having run without any hitch since the commencement. The adaptability of the Gaulard-Gibbs system for house-to-house lighting is, in their opinion, becoming more and more evident, and this installation, when complete, will probably do more to further the employment of electricity as a lighting agent upon a large scale than anything that has hitherto been attempted. The demand for the light in the neighbourhood, now that a general supply is rapidly being provided, far exceeds what will be the possible output, and is a sure guarantee of what awaits the capitalist should electricity be supplied on a large commercial scale. Even the comparatively high price asked does not seem to deter people from wishing to have their premises lighted, and were a good reliable meter only to be had, the demand would be still greater, many persons demurring against paying a fixed annual rental, as they are in many cases away from town during a considerable part of the year. In the interests of the science it is probably very fortunate that a few private gentlemen should have been found willing to risk a considerable amount of money in order to prove to the world that electric lighting was not the failure many would have it appear, and should their efforts be crowned with success, as there seems every probability, the impetus that will be given to this industry will benefit very many besides themselves. As may only be expected, innumerable difficulties continually arise and have to be met, as well as many new appliances which have to be designed in order to meet the requirements of such an installation, but the engineers have so far been able to cope with everything as it has arisen, and are leaving nothing undone that may ensure complete success. One remark may be made upon this installation, and that is, that in no way whatever does it come within the scope of the Electric Lighting Act of 1882. The whole work has been, and will be done entirely without its pale, and consequently none of the clauses therein contained will affect it in any way. The crossing of the streets and houses is only a matter requiring the concurrence of the vestries and householders, and from the elaborately careful way the supply wire has been erected, no trouble on that head need be feared. Of course, overhead wires are not to be chosen should a permanent installation be contemplated; but as the laying of the wires underground would entail coming under the provisions of the Act, so long as it continues in its present objectionable condition, the plan now adopted must be retained. After all, there is nothing dangerous in a *properly* erected overhead line, as constant supervision can easily be given.

Trembling Bells.—A correspondent has, since reading the letter of Messrs. Jolin and Co. in our last issue, joined up two ordinary 2½-inch trembling bells, without alteration in any way, in series, and they both rang perfectly; the battery used was a cell devised by Mr. G. H. Bays, described in our pages of the 30th May.

The Torpedo Scare.—Admiral Hobart Pasha, who remarks that he is probably the only person living who has commanded squadrons or single ships in war when torpedoes were used as offensive weapons has republished the paper which formerly appeared in *Blackwood's Magazine*, as a pamphlet, under the title of "The Torpedo Scare," and published by Blackwood and Sons. Illustrations are given of the defences he employed, and there is appended a reply to the various criticisms which have appeared on his paper. He asks the critics a few pertinent questions, and maintains his view that torpedoes are, at least so far as they have as yet been developed, not likely to be of much value as weapons of attack in naval warfare. But he is of opinion that they are of the utmost importance and value for defence both of coasts and stations. He describes the various torpedoes now known, and gives an account of a recent visit to the establishment of Messrs. Latimer Clark and Co., where he says he saw every sort of invention in torpedo mines for coast defence. He was astonished at their simplicity, their cheapness, and, so far as he could judge, their efficacy. What principally struck him was their proposed system of ground mines, and he felt convinced that the whole coast of the empire, including the colonies, could, with a small expenditure, be secured from foreign attack or invasion.

The Charge of Forging a Telegram.—Lilian Roberts, a student at Malton College, was further remanded at Leeds on Tuesday, charged with forging a telegram purporting to be from the Chief Constable of Leeds to the police authorities at Bozen, Austria, requesting them to release a photographic artist, named Dubois, lately residing at Leeds, who had been arrested on a charge of felony. On the receipt of the telegram the prisoner was released, and he has not since been heard of.

The Society of Telegraph-Engineers and Electricians.—At the invitation of the president, Mr. C. E. Spagnoletti, over 400 members of this society visited the plant works of the Great Western Railway Company, at Swindon, on the 30th ult. The members were conveyed by a special train from the Paddington Station, and after luncheon in the Great Western Volunteers drill hall belonging to the company, were conducted over the works in parties, the various operations in the different workshops being explained and examined. The works, when in full operation, employ about 7,000 hands, and are capable of turning out a complete engine in a week if necessary. The departure from the usual annual evening soirées, which have hitherto been held, was thoroughly appreciated by the members and visitors.

Electricity in the United States.—The adaptation of electricity to lighting in Western America is rapidly extending, as will be clearly seen by perusing an article in our current issue. We can scarcely expect anything to be quickly carried out in this country where lethargy seems to be the order of the day, but signs are plentiful that the applications of electricity are steadily on the increase.

Proposed Electric Railway at Yarmouth.—An effort is being made to introduce into Yarmouth, as a special attraction to visitors, a system of electric railway travelling, similar to that successfully established at Edinburgh, the Crystal Palace, and elsewhere. Mr. Binko has been in Yarmouth, representing, we are told, the promoters, and has submitted plans for the construction of the permanent way along the Drive, or, if that should be considered objectionable, to place the rails on that portion of the sands extending from the Britannia to the Wellington Pier. The Lands Committee has resolved to recommend the Town Council to grant the application.

Underground Wires in New York and Brooklyn.—Last year, it will be remembered, a Bill was passed making it incumbent upon all companies using overhead wires in New York or Brooklyn to cause them to be taken down and replaced by underground wires or cables, failing which it was made the duty of the city authorities to remove them and substitute underground conductors at the expense of the owners. No penalty was provided in the event of non-compliance, and the authorities hesitated to act in the matter, knowing that any interference would result in injunctions or other legal actions. A new Bill has now been introduced, which provides that within twenty days of its passage there shall be appointed in each of the cities of New York and Brooklyn three disinterested persons, who shall constitute a "Board of Commissioners of Electrical Subways." It is made the duty of these boards to enforce the provisions of the Bill of last year, so far as they do not conflict with those of the new Bill; their specific duty being "to cause to be removed from the surface and put, maintained and operated, underground, *wherever practicable*, all electric wires or cables used in any street." This Bill, as may be imagined, is subjected to severe criticism by our technical contemporaries across the water. The New York daily papers, however, express approval of the measure, and say the telegraph companies have shown a contemptuous indifference to the requirements of last year's Act. The Governor having signed the Bill on June 13th it has now become law, and the *New York Times* says:—"It is to be hoped that none of the companies concerned will adopt the unwise course of fighting against the inevitable and embarassing a much-needed work. . . . . The companies can, by co-operating with the Commission, secure the best method of laying their lines beneath the surface, and if the work is properly done it will almost certainly be to their advantage in the long run. They will have to bear the first expense, but there will be a saving in repairs which will in time make it up to them."

Lightning Conductors.—Mr. R. Anderson, F.C.S., has in the press a new and enlarged edition of his work on "Lightning Conductors: Their History, Nature, and Mode of Application." Messrs. Spon are the publishers.

The American Exhibition, London, 1886.—Respecting this projected exhibition, after sharply commenting on the grandiloquent style of the composition of the prospectuses and pamphlets issued in connection therewith, the *Electrical Review* of New York remarks:—"Seriously speaking, we know nothing against the reputation of any man connected with the enterprise, though the Boston *Post* speaks of one of its officers in very uncomplimentary terms, but the whole business has an air of impracticability about it, and we would advise electrical people to carefully look into the matter personally before making any promise regarding it or going to any expense.

A Useful Electric Indicator.—A Missouri lady, according to American information, has taken out letters patent for an electric indicator which, when attached to the bed post, will show at a glance whether there is a horrid man under the bed. Our contemporaries think the saving of time in a year will more than pay the cost of an instrument, and we predict that the thoughtful inventress (is it?) will be hailed by all her sex as their especial benefactress.

State Honours.—A Central News telegram says: Some prominent medical graduates state that should the claims of the medical profession be overlooked in the distribution of State Honours, Dr. Trail, Fellow of Trinity College, the projector of the electric railway in the North of Ireland, and medical man, will be invited to stand at the general election.

An Electric Lighthouse.—A lighthouse is being erected on the top of the cliffs at Dover, over the Channel Tunnel works at the west end of Shakespeare's Tunnel. The lighthouse is being constructed of railway iron, by the Channel Tunnel promoters, and although it is of considerable strength to resist the force of the wind, it has a curious skeleton-like appearance. It will be lighted by the electric light, the power for which will be supplied from the Channel Tunnel works below the cliff. The construction of the lighthouse has been decided upon owing to the fact that the fires used on the shore in connection with the tunnel works have had the effect of decoying ships passing up Channel. The lighthouse will only be used in case of the works proceeding.

Copyright in Telegrams.—The Legislative Department (a Calcutta telegram says) has circulated for the expression of public opinion the draft of a Bill giving newspapers 24 hours' copyright in all news and telegrams obtained at their own cost. The Bill is generally approved by the Anglo-Indian newspapers, the only objection being that in a country of great distances like India the period fixed is not long enough. The native press, on the other hand, which is too poor to afford special telegrams, is raising an outcry against the proposal, as calculated to deprive it of the chief source of its information—namely, the telegrams published by its wealthier contemporaries.

Electricity as a Thief-Detecter.—James Bennett Wilson, aged 16 years, an inmate of the St. Joseph Industrial School, Manchester, was brought up in custody at Manchester Police Court on a charge of having stolen 10d. from the offertory box of the institution. As a protection against thieves, the box is connected with an electric bell in the bedroom of Father Quick, the superintendent of the school. About eleven o'clock on Monday morning the bell rang, and on Mr. Quick going to the room where the box was placed he caught the prisoner in the act of abstracting the money. Wilson was sentenced to one month's imprisonment with hard labour, and five years' detention in a reformatory school.

Transmission of Power.—The following particulars of the cost of transmitting power by the Daft system are given in a pamphlet issued by the Safety Electric Power Company of New York, which possesses territorial rights acquired from the Daft Company. The nominal radius covered is 2½ miles:—Two 250 horse-power engines, $10,000; five 100 horse-power boilers, $6,000; foundations, placing, &c., $2,500; eight dynamos, aggregating 500 horse-power, $20,000; line (approximate), $10,000; receivers, $35,000; switches, &c., $2,000; total, $85,500. Running expenses per diem: Rent of premises, $4; coal (8 tons), $30; engineers, $6; linemen, $5; two firemen, $4, station dynamo men, $4; outside receiver men, $14; 10 per cent. depreciation, $23; oil, waste, &c., $5; per diem, $95. It is assumed that 350 horse-power will be ready for delivery at any moment, and following the ordinary practice of power producers, at least 600 horse-power can be rented therefrom to small consumers, limiting the delivery to, say, 10 horse-power for any one consumer; in this way an average of $150 per horse-power per annum may be realised in New York City, which would therefore return as follows: 600 horse-power at $150 per annum, $90,000; deduct running expenses, $35,000: leaving a net income of $55,000, or 65 per cent. per annum on prime cost. The estimate of running expenses is probably excessive, since 365 days of working expenses have been provided for, whereas this would in practice probably be reduced to 313 days, thus reducing the expenses to about $30,000 per annum and increasing the earnings to $60,000, or 70 per cent. upon the prime cost. The plant for a ten-mile section of street car lines, on the assumption that fifty cars are to be run and that 150 horse-power is ready for delivery on the track at all times, is $62,000. Fifty loaded cars may be moving at the same time. Assuming a run of sixteen hours per day per car, the expenses are put at $49, or less than $1 per car, whereas the care and maintenance of 400 horses, which cost originally $50,000, is put at $286.87 per day, or more than $5 per car.

Climatological Observations and their Relation to Health.—With the hope of fostering regular records of observations at numerous places, the Royal Meteorological Society exhibits at the Inventions Exhibition the equipment necessary for what is known as a "Climatological Station." The following are stated to be among the instruments introduced in this country since the International Exhibition of 1862:—Hall's Electrical Velocity Anemometer (1870), Crossley's Electrical Velocity Anemometer (1873), Hicks's Electrical Velocity Anemometer (1876), Stow's Electrical Rain Guage (1873), Yeates's Electrically Registering Rain Guage (1876).

Telegraphists in Siam.—Three telegraph operators left New York with their wives for Siam a week or so ago, for the purpose of instructing the foreigners in the Morse art. They each get $120 per month, first-class passage to Siam, three years contract, $50 spending money on the trip over, house found, and return passage at end of three years, if alive.

Ingenious Folk.—*Vanity Fair* says:—"Telegraph operators are an ingenious folk. Last week a friend of mine got a prize for a terrier he was exhibiting at the Brighton Dog Show. He telegraphed the glad tidings to his wife—'My Airdrie first; rest nowhere.' This was how that wife was mystified—'My Airball first test now here.'"

More Useful Inventions.—Our American contemporaries—*being* American—feel it incumbent upon them to occasionally enliven their columns with something witty; and so the latest bit of information is that: "Mrs. Prudence Cumback, of Daddsville, O., has patented a muzzle which can be put on the old man, effectually preventing him from kissing the hired girl. If he does, an electric current is produced which rings a bell, strikes a gong and blows a whistle in the kitchen. The factory is running night and day, and is away behind the orders."

NEW COMPANY REGISTERED.

East Kent Company, Limited.—Capital £25,000 in £1 shares. Objects: To carry on in the neighbourhood of Queenborough or Milton, Sittingbourne, Kent, or elsewhere, the business of brick, tile and cement manufacturers, and to produce and use electricity, magnetism or other power. Signatories: *L. Middleton, Ellesborough, Kent, 250 shares; J. H. Postlethwaite, 22, Ryder Street, S.W., 250 shares; *J. Strapp, C.E., Surbiton, 250 shares; G. Gibbons, Norwood Road, Herne Hill, 250 shares; *P. G. Ibotson, 19, Lorne Villas, Southend, 100 shares; F. C. Green, Maidstone, 10 shares; S. Nicholls, C.E., Mansion House Chambers, 2 shares. The signatories denoted by an asterisk are the first directors, qualification 500 shares. Registered 20th inst., by Messrs. Blewitt and Tyler, Gracechurch Buildings, 79½, Gracechurch Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Telephone Company of Austria, Limited.—An agreement dated 22nd ult. (filed 27th ult.), between this company and the Consolidated Telephone Construction and Maintenance Company, Limited, cites: That in

consideration of £10,000 now owing by the Austrian Company to the Consolidated, the former agrees to issue to the latter, or its nominees, 2,000 fully paid shares of £5 each, part of the now unissued capital, and the Consolidated Company agrees to accept the same in satisfaction of the debt.

Lancashire and Yorkshire Electric Lighting Company, Limited.—The annual return of this company, made up to the 16th ult., was filed on the 25th ult. The nominal capital is £100,000 in £5 shares. 127 shares have been taken up, and £2 10s. per share has been called, the calls paid amounting to £315, leaving £2 10s. unpaid. Registered office, 5, St. James's Square, Manchester.

Edison Gower-Bell Telephone Company, Limited.—An agreement dated 24th ult., and filed on the 27th ult., between this company and the Consolidated Telephone Construction and Maintenance Company, Limited, states that the Edison Company is indebted to the Consolidated Company in the sum of £2,339 7s. 8d., which amount the Edison Company is unable to pay, and has also accepted various bills drawn by the Consolidated Company amounting together to £7,837 15s. 5d. In satisfaction of these claims, the Consolidated Company has agreed to accept 20,000 fully paid shares of £1 each, part of the now unissued share capital of the Edison Company, such shares to bear a cumulative preferential dividend of 5 per cent. per annum, and also a preferential right over the rest of the capital in the distribution of the assets in the event of liquidation.

Pilsen-Joel and General Electric Light Company, Limited.—The registered office of this company, formerly at St. Stephen's Chambers, Telegraph Street, is now situated at 15, Edward Street, Hampstead Road, N.W.

Telephone Association, Limited.—The registered office of this association is situte at 57, Moorgate Street, E.C.

CITY NOTES.

The Eastern Telegraph Company, Limited.—This company announces that, subject to the final audit, the accounts show, after placing £100,000 to reserve fund, a balance available for dividend sufficient to pay the fixed dividend of 3s. per share, less tax, being at the rate of 6 per cent. per annum on the preference shares; and a final dividend of 2s. 6d. per share, with a bonus of 1s. per share, both free of income tax, on the ordinary shares of the company, making, with previous payments on account, a total dividend of 6 per cent. on those shares for the year ending 31st of March last.

The Eastern Extension, Australasia and China Telegraph Company.—This company notifies that the coupon on the 5 per cent. Australian Government Subsidy Debentures, due the 1st of July, will be paid on and after that date at Messrs. Barclay, Bevan and Co.'s, Lombard Street. Coupons must be left three clear days for examination.

Western Union Telegraph Company, Limited.—A dividend of 1¼ per cent on the capital stock for the current year is payable on July 15th to stockholders registered on the 20th ult. The estimated available balance is $5,503,175.

West Coast of America Telegraph Company, Limited.—The coupons due on the 30th ult. on the debentures of this company will be paid by Messrs. Barclay, Bevan and Co. The coupons must be left three clear days for examination.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 26th were £2,415, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of June was 3,715, estimated to produce £3,000, against 3,531 messages, producing £3,168 in the corresponding month of last year. The receipts for the month of March, estimated at £3,500, realised £3,510.

PROCEEDINGS OF SOCIETIES.

Physical Society, June 13th, 1885.

Prof. GUTHRIE, President, in the Chair.

"ON the Winding of Voltmeters," by Profs. W. E. AYRTON and JOHN PERRY. As it is most important that voltmeters, ohmmeters, powermeters and ergmeters should be so constructed that the percentage increase of resistance of their fine wire coils due to the heating effects of the currents passing through them should be as small as possible, the question arises as to whether such coils should be made of German silver wire or of copper, or partly of German silver and partly of copper wire, and how the diameter of the wire should vary in different parts of the coil. The authors have therefore been led to investigate the conditions that make this heating error a minimum with cylindrical coils of internal and external radii r_1 and r_0. At a place whose distance from the axis is r, let the cross section of the wire be x_1, ρ the specific resistance of the material; then assuming that $x = x_0 r^a$, $\rho = \rho_0 r^b$, $\rho r = \rho_0 r_0 r^c$, and that a current C in one spire of radius r produces a magnetic effect $\kappa C r^d$ on the suspended needle, they find that the heating error is proportional to

$$r_0 \rho_0 \frac{p^2}{(r_1^p - r_0^p)^3} \cdot \frac{n}{r_1^n - r_0^n} - \frac{r_1^m - r_0^m}{m},$$

where $p = d - a + 1$, $n = 2 + b - 2a$, $m = 2 + 1{\cdot}144\,b - 4a$. The conditions that make this expression a minimum are worked out in the paper, the result being that with one of their magnifying spring solenoid instruments where $d = -1$, the values of a and b giving a minimum value, are $a = 0{\cdot}325$ and $b = -0{\cdot}5$, and since in practice b cannot be negative, they conclude that $b = 0$ and $a = {\cdot}4$ give the best results, *i.e.*, that all the wire employed in the bobbin should be of copper, and the law of increase of cross section proceeding from the centre should be $x = x_0 r^{0{\cdot}4}$. The actual waste of energy in the instruments is next considered; and lastly, the authors show how to pass from a voltmeter with known winding and whose maximum reading is V_1, to another of the same volume and shape whose maximum reading is to be V_2, and they conclude, that as they have shown that the waste of energy is the same in both for their maximum readings, the resistances of the instruments must be proportional to the squares of V_1 and V_2, or following the law already arrived at for a minimum error due to heating, the cross sections of the wires of the two instruments at similar places must be inversely proportional to V_1 and V_2. The employment of outside coils for voltmeters is considered, and it is shown that if we desire the same error in the two instruments due to heating when the outside resistance coils are of the same size and shape, it is necessary to have the same ratio between the resistance of resistance coil and that of the magnetising coil in the two cases. To have a less or a greater error in the second case it is only necessary to have the equation

$$\epsilon \text{ (the error)} = \frac{2 + \text{F. V}}{1 + \text{F. V}}$$

where F is a constant and V the volume of the German silver resistance coil. From this V may be determined, and the ratio $\frac{R_1}{R}$ of the resistances of the resistance coil and the magnetising coil is given by $\frac{R_1}{R} = \frac{F}{D}$ V. where D is a constant which, like F, is obtained from experiments on the first instrument. The diminution of the heating error by using much iron in the instrument so as to obtain the same magnetic action with a much smaller current is discussed, and experiments were shown to illustrate how such employment of iron introduced a permanent magnetism error, and caused the indications of such an instrument on the lower part of the scale to be uncertain and to depend upon whether measurements were being made with an increasing or a diminishing current.

"On the manner in which Light affects the Resistance of Selenium and Sulphur Cells," by Mr. SHELFORD BIDWELL. In a communication made to the Society at its last meeting, the author has described a sulphur cell which behaved in all respects like a selenium cell when exposed to light. The action of this cell was supposed to be electrolytic, the sulphur containing a small quantity of sulphide of silver. If this were the case, the result of a current traversing the cell would be to deposit sulphur upon the anode, and as sulphur has an enormous resistance, that of the cell would increase unless the sulphur thus deposited combined with the silver. It is this combination that is believed to be much facilitated by light, a supposition the author believed he had confirmed by direct experiment. Mr. Bidwell had also measured the resistance of a piece of selenium that was believed never to have been heated in contact with a metal. The specimen was crystallised by heating for some time in a glass mould, two opposite sides cleaned, and two pieces of tinfoil, between which the resistance was measured, pressed against them. In this way the specific resistance was found to be 2,500 megohms, which is enormously higher than that of the selenium in the "cell," a fact tending to confirm the theory that the conduction in such cells is due to the electrolysis of the selenides of the metals forming the terminals produced in the "cooking," and similar to that of the sulphur cell described above.

"On the Error involved in Prof. Quinke's Method of Calculating Surface Tensions from the Dimensions of Flat Drops and

Bubbles," by Mr. A. M. WORTHINGTON. In a series of well-known papers, Prof. Quinke has recorded a large number of measures of flat drops and bubbles, from which he has deduced the values of tensions for the free surface of a liquid and for the common surface of two liquids in contact. The numerical results obtained in this way exceed those obtained from observations upon the rise in capillary tubes, which Prof. Quinke attributes chiefly to the fact that in the latter case the edge angle is not zero. Mr. Worthington, however, shows that the surface tensions obtained by Prof. Quinke with flat drops are too high, this arising from his having assumed that the drops were flat at the vertex. The error thus introduced is very considerable, amounting in most cases to as much as 10 per cent. of the whole value; and upon its being duly corrected, the values obtained do not appreciably exceed those obtained with capillary tubes.

"On a Comparison between the Mercury Standards of H Resistance issued by M. Mascart with those of the British Association," by Mr. R. T. GLAZEBROOK.

Royal Society, May 7th.

With a Note added May 12th.

"On the Electric Resistance of a New Alloy named Platinoid." By J. T. BOTTOMLEY, M.A., F.R.S.E.

In the course of a series of experiments on the electric resistance of various metals and alloys and in particular on the variation of the electric resistance of these metals and alloys with temperature, the author has examined a new alloy (called by the inventor "platinoid"), which has turned out to have important properties.

This alloy is the invention of Mr. F. W. Martino, of Sheffield, who kindly supplied specimens of the metal, and wires specially drawn down to the finer gauges for experiments.

Platinoid is practically German silver with the addition of a small percentage (1 or 2 per cent.) of metallic tungsten. The tungsten is added in the form of phosphide of tungsten, a considerable percentage of which is in the first place fused with a portion of the copper. The nickel is then added; and then the zinc and the remainder of the copper. The mixture requires to be re-fused more than once, and during the process the phosphorus and a considerable portion of the tungsten originally added is removed as scoriæ. In the end there is obtained a beautiful white alloy, which is platinoid. When polished the alloy is scarcely distinguishable in appearance from silver. To test the quality claimed for it as to being untarnishable, the author has been keeping ornamental specimens lying exposed to the ordinary town atmosphere; and has satisfied himself that the alloy has a very remarkable power of resisting the tarnishing influence of the air of a large town.

It is, however, the electric resistance of platinoid that has chiefly interested the author. German silver wire has proved of great use in the construction of galvanometer coils and resistance coils, on account of two important properties, viz., its very high resistance and the smallness of the variation of its resistance with change of temperature. Both those properties are possessed in a still higher degree by platinoid alloy.

The resistance of German silver differs considerably in different specimens. It is commonly stated to be $21{\cdot}17 \times 10^{-6}$ B.A. ohms between opposite faces of a centimetre cube at 0° C.;* or, reducing to legal ohms, $20{\cdot}935 \times 10^{-6}$ legal ohms between the opposite faces of a centimetre cube. The following table shows the resistance of a number of specimens of platinoid wire:

Specifying number.	Diameter in decimals of a centimetre.	Cross Section.	Resistance legal ohms per metre.	Resistance between opposite faces of a centimetre cube legal ohms.
16	·1610	·0204300	·181	$36{\cdot}98 \times 10^{-6}$
17	·1430	·0160200	·202	32·36
18	·1230	·0119400	·288	34·38
19	·1110	·0096770	·353	34·16
20	·0865	·0058760	·555	32·61
A	·0595	·0027180	1·250	$34{\cdot}76 \times 10^{-6}$
B	·0495	·0019240	1·707	32·85
28	·0402	·0012690	2·605	33·06
29	·0340	·0009070	3·412	30·94
32	·0290	·0006605	4·371	28·87
36	·0220	·0003801	8·219	31·24

It appears from these results that the specific resistance of platinoid is about *one and a half* times that of German silver.

The experiments on the variation of resistance of platinoid with temperature were carried on in the following way. The specimen of platinoid to be tested was wound on a wooden bobbin, on the surface of which a screw had been cut, and the spires of the helix were kept separate by lying between the threads of the screw. This coil was immersed in a bath of oil and was connected in series with a known wire of German silver, the temperature of which was kept constant, and with a single Daniell's cell. The differences of potential between the two ends of the platinoid wire and the two ends of the German silver wire were determined by applying the electrodes of a high-resistance galvanometer. The ratio of the differences of potential is the same as the ratio of the resistances of the two wires.

In the following table is shown the ratio of the resistances of a specimen of platinoid wire at different temperatures to its resistance at zero. The wire used was the same as that specified as No. 20 in the table of resistances. The length of the wire experimented on was about four-fifths of a metre. The only trouble in the experiment was the keeping the oil-bath, which was filled with linseed oil, thoroughly stirred, and of uniform temperature throughout.

Temperature.	Resistance. The Res. at 0° C. being = 1.
0°	1·0000
10	1·0024
20	1·0044
30	1·0075
40	1·0066
50	1·0097
60	1·0126
70	1·0134
80	1·0166
90	1·0188
100	1·0209

This gives for the average percentage variation of resistance per 1° C., between the temperatures 0° C. and 100° C., the number 0·02087. A second wire tested very carefully in a similar way gave for this average percentage variation between 0° and 100°, 0·022 per degree, with a steadily increasing rate of variation from the beginning.

To compare this increase in resistance due to increase of temperature with that observed in other metals and alloys, we find that the percentage increase of resistance for 1° C. at 20° C. for copper is 0·388, platinum silver alloy 0·031, gold silver alloy 0·065, and for German silver 0·044. These numbers were obtained by Matthiessen in the course of his experiments for finding a suitable metal or alloy for the purpose of constructing the British Association standards of electric resistance. It appears that the variation of resistance of platinoid with temperature is very much smaller than the smallest observed for any of the metals and alloys then examined.

The modulus of rigidity, the Young's modulus (or modulus for elastic longitudinal extension), and the breaking weight for platinoid wire were also determined. The wire used was a portion of that marked *A* in the foregoing table. This wire is a little larger than No. 24 of the Board of Trade standard wire gauge, and has a diameter of 0·0595 cm.

The rigidity modulus was found to be $4751{\cdot}8 \times 10^6$ grammes weight per square centimetre. The Young's modulus is $1222{\cdot}4 \times 10^6$ grammes weight per square centimetre.

The breaking weight is about $6{\cdot}029 \times 10^5$ grammes weight per square centimetre.

The specific gravity of platinoid wire has also been found by the author to be 8·78 compared with water at 20° C. Platinoid when drawn hard is softened, like copper, by heating and sudden cooling.

* Given by Prof. Fleeming Jenkin, F.R.S., as expressing the results of Matthiessen's experiments.

NEW PATENTS—1885.

7384. "Lighting railway carriages by electricity." L. J. CROSSLEY, R. HANSON. Dated June 17.

7390. "Electric arc lamps." O. ROMANZE. Dated June 17.

7419. "Troughs or conduits for electrical wires or conductors." T. SINGTON, W. T. OLIVE. Dated June 18.

7439. "Apparatus for testing electric batteries." B. M. DRAKE, J. M. GORHAM. Dated June 18.

7440. "Instruments for measuring electric currents." B. M. DRAKE, J. M. GORHAM. Dated June 18.

7461. "Galvanic batteries." A. R. UPWARD, C. W. PRIDHAM. Dated June 18.

7471. "Earth clips employed in forming electrical circuits." A. WHALLEY. Dated June 19.

7510. "Continuous manufacture of light metals by electrolysis." P. JENSEN. (Communicated by J. Omholt and Chemische Fabrik Gössnitz, Botliger and Seidler.) Dated June 19.

7511. "Galvanic batteries." G. BARON DE OVERBECK. (Communicated by F. Hornung.) Dated June 19.

7582. "Telegraphy." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated June 22.

7583. "Means for signalling or telegraphing between railway trains or between trains and stations by induction." T. J. HANDFORD. (Communicated by T. A. Edison and E. T. Gilliland.) Dated June 22.

7584. "Telegraphy." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated June 22.

7588. "Apparatus for making and breaking electric circuits automatically." G. WILKINSON. Dated June 22.

7595. "Device for supporting electric lighting appliances upon gas fixtures." H. H. LAKE. (Communicated by C. A. Hussey.) Dated June 22.

7616. "Electro-magneto motors." G. CUMBERPATCH. Communicated by Recordon & Co.) Dated June 23.

7649. "Printing telegraphs." W. H. DAVIES. (Communicated by G. B. SCOTT.) Dated June 23.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

6319. "Improvements in the manufacture of holders for incandescent electric lamps, and of other articles composed of glass with metal fittings." A. SWAN. Dated April 12. 6d. Has for its object to enable the holders of electric lamps to be manufactured of glass commonly so called, or analogous glassy material such as the material known as "vitrite," by casting or moulding, and securing the metal fittings therein or thereto by the process of casting or moulding the said glass or the like. This will be found fully described and illustrated in the REVIEW for February 21st, 1885.

7516. "The electric and automatic transcription of stenographic signs and characters into typographic characters." W. H. BECK. (Communicated from abroad by G. A. Cassagnes, of Paris.) Dated May 10. 8d. The object of the present invention is in a general manner the automatic transcription of stenographic bands produced mechanically by any system of machines fitted with key boards.

8861. "Improved electrical indicating apparatus for use in transmitting instructions on board ship and for other purposes." R. L. SPICER. (Communicated from abroad by E. W. Lloyd.) Dated June 11. 8d. Consists in a combination of various parts comprising a battery or batteries, electro-magnets, wheels, pawls, dials, pointers and other devices so arranged that a step by step motion is obtained whereby pointers or indicators may be caused to move over dials with rapidity and certainty.

8921. "A portable electric safety lamp for miners, divers, and domestic purposes." E. T. BOSTON. Dated June 13. 6d. Consists of a primary battery of angular porous plates and other cells which contain corrugated or flat angular metal and perforated carbon plates. The outer cells are of gutta percha, wood, glass, or earthenware and metal. The top of lamp is secured by clips having an excentric motion. The incandescent lamp is protected by an outer thick glass and strong metal guard. The battery is so constructed that it can either be worked with or without a ventilating chamber which contains valves.

8999. "Improvements in holders for electric incandescent or glow lamps." J. H. GREENHILL. Dated June 16. 4d. The inventor employs a block of wood or other non-conducting material either cylindrical, conical, square or oblong in shape. Projecting from the base of this block are two separate supporting wings of sheet metal or other conducting or non-conducting material, curved or hollowed at the ends against which the neck of the lamp abuts or rests. Each of these supporting wings may (if of metallic substance), or may not be, electrically connected to each terminal screw. Two independent "trap" springs are used, the one end of each being in electrical connection with the respective terminal screw, while the other end of each spring projects slightly beyond the block to permit the external loops of the lamp to readily engage with the springs, and slip along them until where the projecting wings support the lamp, which is thus securely held, while perfect electrical contact is made with the loops by reason of the spring's pressure. To prevent the accidental contact of the springs with each other, and thus causing "short-circuiting," there is a horn or pin of insulating material to project between the free ends of the springs.

9185. "Improvements in holders for incandescent electric lamps." A. SWAN. Dated June 19. 6d. Consists of a first part to which the external wires are attached, the ends of the said wires being each received in the slit or slot of a split screw secured to the said first part, upon each of which screws a nut is mounted, which can be screwed down to give a good contact. The said nuts each form the one end of a spiral spring, the other end of each spring coming into contact with contact pieces, in a second part to which the bulb is fitted, the terminal wires protruding from the bulb being attached or fitted into these contact pieces. The parts are secured together by a collar piece with undercut inclined slots in each end. A pin or pins on the first part of the holder engages or engage with the slot or slots in the one end of the said collar after the manner of a bayonet joint fastening, and similarly a pin or pins on the second part of the holder engages or engage with the slot or slots in the other end of the said collar, so that when the said two parts of the holder are in position the aforesaid springs are in compression, and give a good and firm contact for conveying the current from the one part to the other of the holder.

9341. "Improvements in electric motors for railway cars." J. H. JOHNSON. (Communicated from abroad by A. W. Adams, of America.) Dated June 24. 6d. The object of this invention is to provide an arrangement by which the field and rotating armature of an electric motor and the gearing or transmitting devices through which motion is communicated from the armature to the wheels of the car or vehicle, can be supported in such manner as to be independent of the body of the car, with a view to permitting the latter to move freely without disturbing the relations of the motor and transmitting devices to the driven wheel or wheels. To this end the armature is mounted upon the axle of the driven wheel or wheels and the field is supported in a frame, which is rigidly secured to or formed in one with the axle or journal boxes of said wheels, the said frame also carrying the intermediate gearing through which the armature is connected to the wheel or wheels to be driven. In this way the field and all other parts carried by the frame always occupy the same relative position to the wheels and armature and are not affected or disturbed by the spring connection between the body of the car and the wheels or their truck.

9409. "Improvement in dynamo-electric machines." A. SOREL. Dated June 25. 6d. Has for its object to construct a simple dynamo-electric machine by utilising the "Foucault" currents generated in a copper disc when turned in front of the poles of a magnet. For this purpose the inventor forms a disc by winding on two symmetrically placed cores a flat copper wire, and encircling them by a hoop. The cores are preferably made of vulcanite, and have the shape of segments placed diametrically opposite each other and rounded at their corners. The wire is first wound on one of the cores, so as to form a flat spiral, then led to the other core and wound so as to form on the same a second spiral of the same size and shape, and finally the right and left spiral are secured together by a circular hoop. The disc is mounted on a horizontal shaft, and between two frames or stands, carrying a pair of horse-shoe magnets. The said magnets are placed parallel to each other at equal distances from the axis of the disc, and so that the disc rotates between the poles of each magnet. To the inside of each horse-shoe magnet, and concentrically with the disc, is attached a pair of segments of sufficient size to periodically overlap the core of every spiral during the revolution of the latter. The right and left face of the disc nearly touches the inner face of the said segments or pole-pieces. On the shaft of the disc is mounted a commutator, consisting either of a divided ring or of two parallel rings, and of brushes connected with the two ends of the copper wire forming the spirals.

9724. "Improvements in apparatus for inducing electric sparks for gas lighting and like purposes." A. R. MOLISON. Dated July 3. 6d. Has for its object further improvements on the apparatus for which letters patent were granted No. 1295 of 1883, and No. 5036 of 1883. The present invention is designed to further simplify and cheapen the said apparatus.

9896. "Improvements in electric mangers for the prevention and cure of crib biting." B. S. WESTON and H. S. WILTON. Dated July 8. 6d. To prevent the working parts of the electric manger cap being put out of order by water, food, &c., falling from the horse's mouth the inventors make the top or cap of the manger in the form of an unequal ridge roof inclining towards the horse, and projecting over the manger top, front and back. This roof is of metal, and is divided and insulated through the ridge with a strip of vulcanite. The roof is capable of vibrating by means of hinges placed under the back end, upon springs placed between it and the manger top, the horse bites the ridge of this roof, which, being an obtuse angle, necessitates a slight downward pressure to give him grip, this downward pressure makes contact at the springs before mentioned with battery and coil, and a shock passes through the mouth of the horse, which has now closed the secondary circuit between the insulated sides of the metal roof.

9929. "An improved electrometer." A. WRIGHT. Dated July 9. 4d. Consists of a movable pear-shaped plate (hereinafter called the armature), capable of rotating in a plane *slightly inclined* to that of a fixed plate placed very close to it. The two points, between which it is desired to measure the difference of potential, are connected to the armature and fixed plate respectively, and the attraction between these plates, consequent on their difference of potential, causes the armature, in its endeavour to get nearer the fixed plate, to move through a certain angle from its zero position until an opposing force, such as gravity or that of springs, which tends to keep it at its zero position, balances this attraction, the amount of rotation forming a definite measure of the difference of potential required.

9961. "Diaphragms and attachments for telephonic purposes." G. GRAY. Dated July 9. 4d. These diaphragms are similar to ordinary metal diaphragms, but are preferably made of glass.

10238. "Electric safety fuse." R. E. DUNSTON. Dated July 16. 4d. Fig. 1 is a longitudinal section, and fig. 2 a plan of electric safety fuse, according to the invention. Two side pieces of wood, *a*, *a*, are fitted tightly against shoulders of two round metal pins, *b*, *b*, through holes in which is passed a lead wire, *c*. These parts form together a small removable frame, of which a number may be kept ready for successive use with the rest of the apparatus, which consists of a base, *d*, of wood or other imperfectly conducting material, having fixed on it two pieces of metal, *e*, e^1, each made with a hole and pinching screw to hold the ends of the circuit wires. The piece, *e*, is hollowed in front to receive one of the pins, *b*, and the other piece, e^1, has attached to it a bent metal spring, *f*, which is hollowed to receive the other pin, *b*. The removable frame carrying the lead wire, *c*, can in a moment be

sprung into its place, making good contact with *e* and *f*, and should the wire, *c*, be fused by an excess of current, the spring, *f*, can be pulled back by the finger sufficiently to permit of the

FIG. 2.

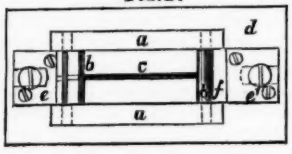
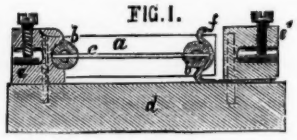


FIG. 1.



frame being removed, whereupon a frame containing a fresh wire, *c*, can at once be sprung into its place.

10323. "Improvements in dynamo-electric machines." A. M. CLARK. (Communicated from abroad by E. B. Cutten, of America. Dated July 18. 6d. The invention consists in a dynamo-electric machine constructed with the parts of the field magnet that receive the wire, tapered from the pole pieces to the yoke.

10486. "Improvements in electrical switches." F. WYNNE and G. C. SILLAR. Dated July 23. 6d. The type of switches or contact makers and breakers to which the invention relates, is that in which the electrical contacts are made by means of metallic surfaces, sliding on one another, for use in electrical circuits in which a novel arrangement of parts is employed, and in which the main contact surfaces are kept distinct from the parts which are exposed to the destructive action of the sparking due to the making and breaking of the circuit, and the contacts between the connecting wires of the circuit and the parts of the switch are made certain.

10733. "Improvements in battery cells." J. C. HOWELL. Dated July 29. 2d. Each cell consists of a wooden box, lined in the first instance with a cement made of a mixture of pitch tar and tallow suitably tempered, the box is then lined with sheet glass bedded firmly into the cement whilst hot. Hot cement is run over the angles formed at the junctions of the sheets of glass and whilst hot is sprinkled over with powdered glass. Suitable openings may be left in the woodwork at the sides, ends, and bottom, so as to leave the glass exposed, and through such openings the action of the cell may be watched.

10852. "Improvements in electrical brakes for railway vehicles and for other purposes." G. FORBES. Dated August 1. 6d. The inventor takes a railway wheel, either made specially or an ordinary one adapted and altered to the requirements, and on the outside face of it (or on the back of it, whichever be most convenient) he puts a ring of metal, consisting, by preference, of rolled or cast steel, or it may be of other magnetic metal. This ring is faced up smoothly and is of any convenient width and thickness, and fastened to the wheel by bolts and nuts or other convenient means. The outer edge of this ring is fixed as near the outside rim or edge of the wheel as it can be, having regard, if it be on the back of the wheel, to "guard rails," crossties, &c. The inventor then takes a coil of insulated wire or tape (high conductivity copper by preference), of any convenient area, in cross section. The number of coils of wire or tape is regulated by the electric and magnetic results (either or both) which we wish to effect. This coil of wires is placed in an annular half tube of soft iron, that is, a half tube in the shape of a ring, and place it so that the open space containing the coil of wire or tape, faces the ring, before described as being fixed to the wheel. This annular half tube is made of soft iron, by preference, and is fitted in position by arms, or projections, or a disc, to a suitable boss, which is carried by the axle to which the wheel is fastened. The axle is free to revolve within this boss. The boss, and the connecting means, hold the half tube at a small distance from the ring on the wheel and the whole is kept from revolving, when the wheel and axle are revolving, by means of guides, or stops, fitted to the underframe of the vehicle, or to any other suitable part of the vehicle. The two edges of this annular half tube are (when the coil of wire or tape has a current of electricity sent through it) opposite poles and on each edge (or near the edge) we place brackets (by preference of spring steel) and on these brackets we fasten four rings—one ring being outside the outer annular half tube edge the second inside the same—the third inside the inner annular half tube edge and the fourth outside the same edge; so that one ring is on each side of the two edges of the annular half tube. These four rings are made, by preference, of hard rolled steel, and project farther towards the wheel than the edges of the annular half tube. These projecting surfaces are inclined at a suitable angle, so that when the rings are drawn towards the wheel only a small surface touches the ring on the wheel, but as they are pressed still more and give way by reason of the pressure causing the supporting springs to give, the surface in contact with the ring on the wheel increases, till the maximum surface in contact is reached, when these rings and the edges of the soft iron annular half tube are all in contact with the ring on the wheel. With a feeble current the rings with inclined edges or of whatever shape are drawn into contact with the wheel by the magnetic attraction of the annular half tube. Local electric currents are thus created which absorb the energy of the revolving wheel and act with a corresponding retarding energy. On increasing the intensity of the current increased pressure is brought to bear against the wheel, and the edges of the annular half tube, as well as the surfaces of the rings, are all pressed against the wheel, and the magnetism produces a brake pressure which can be increased to any desired practical limit. This extreme pressure—or any lesser pressure—can be maintained at will by the action of the man or men who have control of the brake.

10932. "An improved alloy chiefly designed for electrical conductors, and process of manufacturing the same." H. H. LAKE. (Communicated from abroad by T. Shaw, of America.) Dated August 15. 4d. The inventor first melts copper and then adds aluminium, a little at a time, with a flux consisting of palm oil, stirring well all the time with a pine stick, he then adds phosphorous, stirring again, and then pours into chill moulds.

CORRESPONDENCE.

Secondary Batteries.

The voluminous letters you publish in this week's issue, had they been written by independent and disinterested persons would doubtlessly have been crushing rejoinders to my paper on "Secondary Batteries," in which I endeavoured to describe some forms of secondary batteries other than those manufactured by the Electrical Power Storage Company.

I propose to reply to the letters collectively (excepting two, to which I shall refer later), as they are written by those either connected with or interested in the E.P.S. form of secondary battery.

To commence with, I think it would have been more advantageous to the advancement of the interests of the E.P.S. Company, had Messrs. Sellon, Drake, and Reckenzaun first consulted together, so as to have agreed upon a common line of criticism, instead of writing independently, thus, in several instances, contradicting each other, and so very materially depreciating the otherwise energetic and laudable defence of their wares.

Perhaps it will relieve Mr. Reckenzaun's peace of mind when I tell him that I wrote this much-maligned paper exactly twelve months ago, and therefore could not give an adequate description of his latest inventions and improvements, which, by the way, I regret to learn for the first time that others are obtaining the credit for. He may also rest assured that should I at any time ever have courage to write another paper, I shall first consult him, and *not forget* his own inventions, so as to be certain of a paper that students *may* read.

Mr. Reckenzaun questions the capability of a Planté battery discharging more rapidly than one of the Sellon-Volckmar type, and Mr. Drake says that my statement cannot be based upon experiment; but I can assure him that it is, and, moreover, that I have experimented with almost every form of battery, including the E.P.S. cells. I never stated that equal weights of the two types would give equal results, as I do not consider that comparisons of work to weight are of any use for determining the merits of batteries as used for ordinary lighting purposes; the first consideration being durability, not weight. If these gentlemen will give themselves the trouble of comparing the rate of discharge recommended by the manufacturers of batteries of the Sellon-Volckmar and Planté types for the same capacity (not weight), they will see that the latter is capable of discharging at a very much higher rate than the former. I notice, at the same time, that Mr. Drake says that he has discharged cells at a very high rate, *but cannot recommend* it for regular work; surely such a statement as this had better have been left out; nobody wants to know what they must not do, but what they may do in practice. He then proceeds to give an interesting account of some experi-

ments he has carried out with the Planté type of cell, but these seem, very curiously, to have altogether failed; the conclusion he arrives at being that they are worthless. On this point, perhaps, others will have something to say, for everyone knows that there are a number of the Planté type of batteries at work, and giving very good results. Evidently his ideas as to how to work this particular form are more than sufficient to explain the deplorable failures he has experienced, and I can only hope that those already using this particular type will not see Mr. Drake's letter, as they might in their dismay be so overcome as to at once order a set of the E.P.S. cells to replace them. Perhaps after Mr. Drake has had a little more experience with secondary batteries than he has as yet been able to gain since joining the Electrical Power Storage Company, he will find out, and even agree with some well-known electricians, that the Planté type is at least as good as the E.P.S. I also strongly recommend to his notice some of M. Planté's writings upon the subject for the coming winter evenings.

Mr. Drake considers skilled labour for maintaining secondary batteries in good working order as unnecessary; but to carry out Mr. Reckenzaun's *proper way* of testing, it seems that it is necessary. Would Mr. Drake also be good enough to explain exactly what takes place when momentarily sparking the cells (to test their condition), that is so fatal to them?

With regard to the vital question of the life of the plates, I would inform Mr. Drake that, though he says 40,000 plates may now be working, that have already lasted more than six months (a fact I am perfectly prepared to admit), I know of over 80,000 that did not last three months; and, moreover, that these failed long before my paper appeared, so that I was not the cause of all this misfortune. I have also noticed, as requested, the goodly array of testimonials, and feel much flattered by being considered of sufficient importance to have my opinion published, only I hope that the company was not put to so much trouble and anxiety to obtain the other expressions of opinion, as it might somewhat detract from their merits. I can only account for the number of failures, and the deplorably short life of the E.P.S. cells, by the explanation given by Mr. Sellon that the company turned out bad and clumsy work; but all this is now past, I hope, thanks to the energy and ability of their new managing engineer.

In conclusion, I feel a burning curiosity to know who "Nemo" is. Will not he be good enough to publish his name? I cannot help thinking that anyone who criticises should have the courage of his opinions and append his own name, instead of hiding himself under the cover of a synonym that at once stamps him as "nobody." I also tremble for Mr. Albert for having, in a moment of apparent weakness, cast a doubt upon the much heralded perfection of the E.P.S. cells.

F. Geere Howard.

Cleveland Street, W.,
June 29th, 1885.

In reference to Mr. Reckenzaun's statement, I think, if he can call to mind, some of the special plates constructed for the tramcar did give a little trouble at first. As to Mr. Drake and "Nemo" saying you are not to try the cells by flashing them with a piece of wire, it is rather surprising that the Storage Company should issue printed instructions telling you to do the same. I think Mr. Sellon is making a great mistake when he states that under-gardeners or labourers of average intelligence could do the work required with engine, dynamo and accumulator. There are some exceptions, but all I know of are Mr. Swan's at Bromley and Mr. Sellon's at Sydenham; but I think these installations are under the supervision of those gentlemen.

It is very misleading to the public for Mr. Sellon to state this, for if the under-gardeners, &c., are of so much use, why does he not have them at the company's works, where they would be much cheaper, and not pay practical men the price? He might try for an experiment a gardener in the dynamo room, and let us know the result. In my humble opinion the drawback to accumulators is that they are not patronised by the gentlemen at the head of the company. If they are so economical and beneficial, why does not Sir D. Cooper have engine, dynamo and accumulator at his residence? Or perhaps Mr. Green, in Billiter Avenue, can let us know why he had it cleared out of his offices. Was it because he could not get an under-gardener, or was the accumulator and an experienced man to look after same, too expensive? The least said about the torpedo the better. The latest orders for charging cells with 59 plates is 25 ampères per plate, which brings them up to charging capacity 1,475 ampères.

As I am still in the dark, will some one be kind enough to inform me if my cells are 3, 4 or 5 H.P.?

Henry Albert.

Plaistow,
June 27th, 1885.

If Mr. F. G. Howard, in his paper upon secondary batteries, had particularised the various causes of failure that have actually occurred under his own observation, instead of limiting their durability without a word of explanation, he would at once have conferred a benefit upon the electrical world in general, and have been spared the imputation of making rash statements without proper data wherewith to substantiate them.

I am directly interested in the satisfactory working of three installations of secondary batteries at the present time, which have had respectively, seven, ten and sixteen months' wear in constant use without showing signs of deterioration, and this without the skilled attendance that seems to Mr. Howard to be indispensable.

I consider that an unskilled attendant is a far more trustworthy custodian of such an installation than one possessing the conventional "fair knowledge of electricity," the former doing simply what he is told and no more, while the latter is apt to experiment with more or less disastrous result. However, no attendant could be blamed for bad working if their code of instructions comprised the "short, thick wire" test.

That "a little knowledge is a dangerous thing" is shown rather forcibly by Mr. Albert's letter upon the subject in your last issue.

With regard to the testing of secondary batteries, I consider that a recording instrument that will integrate time and current to be a more reliable test for charging than any form of acidometer, since, in a tightly packed cell, the specific gravity of the solution cannot be uniform. I have used my energy recorder in circuit both in charging and discharging during some recent experiments, which has enabled me to tabulate the results with sufficient accuracy for all ordinary purposes.

There is no doubt that the secondary battery is yet capable of improvement in the future, but at the present time its efficiency is such as to render the storage of energy for electrical traction and kindred applications practicable, while its durability and reliability has been proved to be infinitely beyond the narrow limits assigned by Mr. Howard.

Fredk. Walker.

36, Spondon Road, Tottenham.
June 29th, 1885.

Edison's Electric Meters.

In reply to your item on Edison's meters, published in your issue of May 30th, I wish to state that I am largely interested in the correctness and reliability of those meters, and for that reason regret deeply that such an article should find its way into print. It is not in the meter that the fault lies, but with the persons who had the same in charge. It is a case of shameful ignorance on their part.

I have been working with Edison meters for months, and have put them through tests and trials of the severest nature, with but one object in view, and that to prove their correctness. Several of these tests were practical monthly readings of the meters, with a correct record of the number and size of lamps on the same, time in hours of actual burning, and absolute electrical pressure or E.M.F. on the lamps while burning. This pressure was always kept at one point (105 volts), during each test. If you know the price to charge per standard lamp hour (a standard L.H. is one 10-C.P. 105 volts, burning one hour), said price based on the price per thousand feet of gas, you can easily ascertain the amount of a consumer's bill from the lamp-hours recorded.

In each test the deposit shown by each meter corresponded very nearly in dollars and cents with the amount of the bill figured from lamp-hours recorded. I not only tried separate meters on so many lamps, but also put a number of meters in series on a certain number of lamps, and got exceptionally good results from each, and in several, results that differed from each other only by ½-cent. I will submit one case. This was a 6-light Edison meter. Number of lamp-hours recorded, 909·6; amount of bill at ¾-cent. per lamp-hour, $6·822; amount of loss shown by meter, ·525 milligrammes of zn.; at $13.23 per gramme, lost $6·825. I am now running a test, and if you desire I will make a table of the same and forward you the result for publication.

Now, I conclude that the report brought to your notice arose through careless or bad handling, rather than from defectiveness of the meter. I can willingly concede faults in a machine when proofs are brought of the same, but when the faults seen and complaints made arise through ignorance, or, still worse, gross carelessness in the management of the same, I am equally ready to defend it and expose the culprit. We have been using the Edison meters here for more than 10 months, and in no case since under my charge have they been accused of incorrectness, nor has any question been raised as to their reliability. We have customers using both our light and gas, sold to them by meter, and they have, without my knowledge, tested the correctness of the meters several different times. I remember two cases where they turned off the electric light without my knowledge and burnt gas the whole month, with but the one purpose of seeing how large a bill I would present to them. I knew nothing of this until I changed their meter at the end of the month, ann then it was evident from the reading that they had burnt no light, and I surprised them greatly by telling them they had not used any light.

As I said before, I still think the fault complained of lay with the persons who had the meter in charge, rather than in the meter. They were either entirely ignorant of the meter, and unfit for handling the same, or they stand accused of the grossest carelessness.

Circleville Meter-Man.

Circleville, Ohio,
June 11th, 1885.

The Wimshurst Machines.

With reference to the paragraph in the current issue, I may inform you that the absence of constant attendance at the above electrical machines, and the cause of their not being occasionally at work, is due to the very limited space assigned me, and to the nearness of the machines to the structure of the building, &c. To work the big machine situated as it is would be unfair—except, of course, it be before scientists only, who would properly value the surrounding conditions in combination with the results.

Again, in connection with the exhibit should be the knowledge that everything which I do, or have done, in producing and exhibiting the machines is a voluntary contribution to science, the contribution being about as large as I think prudence dictates; complaint that I do not go further seems to me therefore unmerited.

I now forward you several of the detail particulars of the machines, and shall be glad if you think any, or all of them of sufficient interest for publication.

James Wimshurst.

4, The Grove, Clapham Common,
25th June, 1885.

[The machines devised by our correspondent have already figured in our pages.—EDS. ELEC. REV.]

Secondary Battery Patents in America.

Some few months since we saw in the "Notes" of your valuable journal a reference to the pending litigation in the United States Patent Office between Mr. John S. Sellon, of London, England, and Messrs. Starr and Starr, of Philadelphia, U.S.A. To enable you to complete your notice of the history of that litigation, we take pleasure in advising you that a final decision has been rendered by the Commissioner of Patents, and confirmed on rehearing, in favour of Starr and Starr as against Mr. Sellon, and awarding them the patent.

The subject, as you will remember, is an important one, relating to secondary batteries or accumulators.

Messrs. A. Pollok and Phillip Mauro, of Washington, D.C., and with them Mr. Boutwell, ex-Secretary of the United States Treasury, appeared for Mr. Sellon, while Mr. William J. Peyton and Messrs. Baldwin, Hopkins & Peyton, of Washington, appeared for Messrs. Starr & Starr.

The litigation has determined the control of important features in secondary batteries, as far as concerns the United States.

We have long been subscribers to your journal, and send you this information, as it appeared from your previous article that the litigation was likely to terminate in favour of Mr. Sellon.

Baldwin, Hopkins & Peyton.

Washington, D.C., *June 17th*, 1885.

[The following letter, bearing on the above subject, has been sent to us in response to an enquiry which we thought it desirable to make upon the receipt of the communication from Messrs. Baldwin, Hopkins and Peyton.—EDS. ELEC. REV.]

In reference to your enquiry as to the present position of one of my secondary battery patents in the United States, about which you have received a communication from Washington, I beg to state that the application of Messrs. Starr and Starr to be allowed to have issue of a patent in their name, which has been apparently copied almost word for word from one of my already issued patents of much earlier date, has been allowed by the Commissioner of Patents; but that in consequence of what I consider the gross injustice of this proceeding, further steps are being taken on my behalf to prevent such issue, and that even if such steps should not be successful, and the patent should be issued, the position will be that a court of law, in which Messrs. Starr and Starr can be examined on oath, will be called upon to decide as to the rightful owner of the particular invention, instead of an official of the Patent Office.

This case is so typical a one of the mode of procedure which would seem to be frequently adopted in the United States Patent Office in respect of patents taken out by foreigners, that so soon as I have the leisure to refer to the papers connected therewith, I propose, with your permission, to forward to you for publication a short epitome of what has taken place in it up to date.

Not long since, in discussing the anomalies of the United States Patent Office law with an eminent American, he remarked to me:—"My good sir, our patent laws were made to protect the Americans, not for you outsiders." So it would seem.

John S. Sellon.

The Hall, Sydenham,
July 1st, 1885.